ROOKLYN BOTANIC GARDEN RECORD

PLANTS & GARDENS

SOIL

Right Way to Use:

Fertilizers

Composts

Conditioners

Lime

ere to Have oils Tested

Control of Soil Pests

worms—Fact vs. Fancy

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SPRING 1956

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SERIES

NO. 1

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Editorial

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McFarland

A successful garden, whether vegetables or flowers, demands a rich, well-structured soil.

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES
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BROOKLYN 25, NEW YORK
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Spring, 1956

Into the dark earth man cannot easily see, but let that be no measure of the drama enacted there, nor any measure of the size of the stage—for the soils of the earth are the face of the earth. The birth and life and death of all animals and plants are our mainstream on this "living earth", and almost all that happens to living things (except for the sea) occurs on or in the few inches or feet of soil that make up the earth's mantle. Although this Handbook deals with man and the working out of an effective partnership with soil, it is important for a moment to take the long view. Here it is, with a few deletions, in the words of Paul Sears penned some twenty years ago:*

"The face of the earth is a graveyard, and so it has always been. To earth each living thing restores when it dies that which has been borrowed to give form and substance to its brief day in the sun. From earth, in due course, each new living being receives a loan of that which sustains life. No plant or animal can establish permanent right of possession to the materials which compose its physical body. What is lent by earth has been used by countless generations of plants and animals now dead and will be required by countless others in the future.

"Left to herself, Nature manages these loans and redemptions in not unkindly fashion. She maintains a balance which will permit the briefest time to elapse between burial and renewal. The turnover of material for new generations to use is steady and regular."

Such is the role of Mother Earth, whose resources are never idle; such, indeed, is the role of the soils of the earth.

In the pages that follow, thoughtful and professionally trained authors join with the Editors and our Editorial Committee to answer common questions on soil management:

> Wherever you live, you can send soil samples for testing (p. 20); and at long last there is something new in fertilizers (p. 103).
> If in doubt about using rotary cultivators, see pages 31 and 46.
> Then, too, subsoil can be made into topsoil, right where you want to use it (p. 42).
> Controlling soil pests is little understood by the average gardener; we think the article on page 51 is the best of its kind.
> And now that the hullabaloo is over, soil conditioners have settled down to a useful career in improving the structure of clayey soils (p. 64).

Among the soil's inhabitants are myriads of microorganisms—of thousands of different kinds. Some of these produce antibiotics that save human life, and serve in many other roles (p. 32). Other articles will bring home points you have wondered about and questions you have raised—but never before had satisfactorily answered. Don't miss a page of this Handbook on Soils!

Sincerely yours,

George S. Avery, Jr.

Director

*from "Deserts on the March," University of Oklahoma Press, 1935.

Advertising Directory. The closing pages of this handbook constitute a directory of sources for commercially available products that have to do with the well-being of soils. We hope to extend the idea somewhat in the future, knowing that readers will find it helpful.

IS YOUR GARDEN ON A STARVATION DIET?

How to properly evaluate and use commercial fertilizers

William J. Tucker

MY wife's Aunt Ruth is really a very fine gardener. One of the keenest rewards bestowed upon her as a gardener is the deep-down feeling of satisfaction and accomplishment which she gets each time she views the riot of color and beauty that is her garden. Then, too, she enjoys the envious glances that neighbors and friends give her garden.

Unfortunately, many people are discouraged in their attempts to join the ranks of gardeners because they think they cannot find the "combination." They get little enjoyment from the sparse, spindly, unhealthy plants over which they toil, struggle, and occasionally cuss, and less enjoyment when they compare a neighbor's bountiful harvest. What they lack, probably, in many cases is a little information about plant nutritional deficiencies.

We would be aghast and probably infuriated if anyone suggested that we were seriously neglecting the nutritional aspects of our children's diets. Why is it then that so many of us neglect the feeding of plants? Why have we in many cases placed them on a starvation diet? The answer lies mainly in the fact that supplying fertilizer to our gardens or to individual plants seems to have an air of mystery or confusion about it for many gardeners. There are so many fertilizers, so many scientific numbers and symbols, so many claims, so many dangers; in short, so many complexities, that too often fertilizer usage is put off even though the need for it may be recognized.

Perhaps it would be helpful to spend a moment or two on this question of fertilizer or plant food for the garden. A few simple facts can make the purchase and use of fertilizers an easy, routine, and profitable practice.

Mineral Elements

Commercial fertilizer, or plant food, if you will, supplies those mineral elements which are most often lacking or seriously deficient in the soil. It has been established that fifteen chemical elements are necessary for the growth of plants. Those that occur in compounds in the soil are: phosphorus, potassium, nitrogen, sulfur, calcium, iron, magnesium, boron, manganese, zinc, copper, and molybdenum. The others, carbon, hydrogen, and oxygen, get into plants from the atmosphere or from soil water.

Although all of the above elements are essential for plant growth, some are needed in greater amounts than others. Thus we hear the term "trace" or "minor" elements describing zinc, boron, manganese, and others because they are required in very small amounts by plants. These elements, however, are just as essential for plant growth as are nitrogen, phosphorus, and potash (potassium) which are required in much larger amounts.

Purpose of Commercial Fertilizers

Commercial fertilizers are formulated primarily to cater to the recognized mineral plant food needs of the soil. They

Author photo

Effect of lack of minerals on chrysanthemums. Plant at right had all necessary minerals; others from left to right are deficient in nitrogen, phosphorus, and potassium respectively.

are not designed to replace organic matter or to condition the soil. On the other hand, many garden soils having a fine tilth and texture as the result of the right use of organic materials, can still fail to give good plant growth because they lack sufficient amounts of the necessary mineral plant food. It is not important here to go into the familiar "organic" vs. "inorganic" fertilizer theme. It is sufficient to say that the need for both organic matter and mineral plant food in the soil is well recognized and indisputable. The important thing from the gardener's standpoint is knowing which of the two needs he is trying to serve and to keep from confusing the one with the other.

In our flower garden (not very extensive) and on our shrubs (less so), my wife makes very liberal use of decayed leaves and other composted organic materials, as well as peat moss. But she does not overlook the fertilizer needs; 5-10-10 or 6-12-6 fertilizer is used very liberally in the garden and especially on the lawn.

Soil Testing

Before using fertilizer the home gardener would be wise to have a sample of his soil tested to determine the level of the nutritional elements just mentioned. The soil test can be arranged through the agricultural experiment station in virtually any state. Furthermore the station will often interpret the test and offer helpful suggestions about what amount of particular fertilizer to apply. (See page 20.)

At the same time the tests for nutrients are made, tests are also run to find out how "sweet" or "sour" the soil is. A sour soil is one which is acid, a sweet soil is alkaline. The degree of acidity or alkalinity is another important factor in plant growth. It is expressed by a numerical value called pH. The drawing on page 26 illustrates this. The scale of pH values runs from 1 to 14. The neutral point is 7, neither acid nor alkaline, and in general this neutral zone is desirable, at least for a great many plants.

Agricultural limestone, which is an alkaline material, is used to correct the soil acidity if it is too great. At the same time it supplies the plant food element, calcium, and varying amounts of magnesium and others. Limestone can increase the effectiveness of commercial fertilizers on those garden soils where acidity is too great. Having the pH value of his soil checked can be of great help to the gardener, particularly if he has been having difficulties, and acidity of the soil has not been recognized as a source of the trouble.

Fertilizer Composition

Once the needs of the soil have been established and the gardener is ready to use plant food, what should he look for at the nursery or farm store where he will go to buy it?

First and foremost, commercial fertilizer should always show the chemical analysis on the bag or other container, such as 10-6-4. The first figure (10) in the analysis always denotes the percentage of nitrogen. The second figure (6) denotes the percentage of available phosphoric acid (P_2O_5) and the third figure (4) denotes the percentage of water soluble potash (K_2O). Another example would be 5-10-5, meaning 5% nitrogen, 10% available phosphoric acid (P_2O_5) and 5% water soluble potash (K_2O). If one of the three major elements is lacking in a fertilizer a zero appears in its place. Thus 0-20-20 means no nitrogen, 20% available phosphoric acid, and 20% water soluble potash.

Fertilizer manufacturers are required by law in all 48 states to register the various commercial mixtures which they are offering for sale. Further, they are required to maintain rigid standards with respect to the minimum guarantees which they claim on the bag. State inspectors take samples at retail points and submit them to state laboratories for chemical analysis to insure that the label guarantees are met. The home gardener is, therefore, well advised to read the labels carefully. He may save much money and disappointment by avoiding "wonder working" or "miracle" fertilizers bearing no guaranteed analyses. He would be equally wise to maintain a sense of good judgment when reading some of the ridiculous claims which are dreamed up by overenthusiastic promotion people.

There are a number of different kinds and grades of fertilizer which are available in most communities. Many soils need a complete mixed fertilizer; that is, one containing all three of the major elements, nitrogen, phosphorus, and potash. Examples of such complete mixed fertilizers are 5-10-10, 5-10-5, 6-12-6, or 10-6-4. The reason that the numbers are changed somewhat in these formulas or grades is to make it possible to place

Key to Mineral Deficiencies Shown by Rose Leaves on Opposite Page

Iron lacking. Leaves pale, color present only around veins.

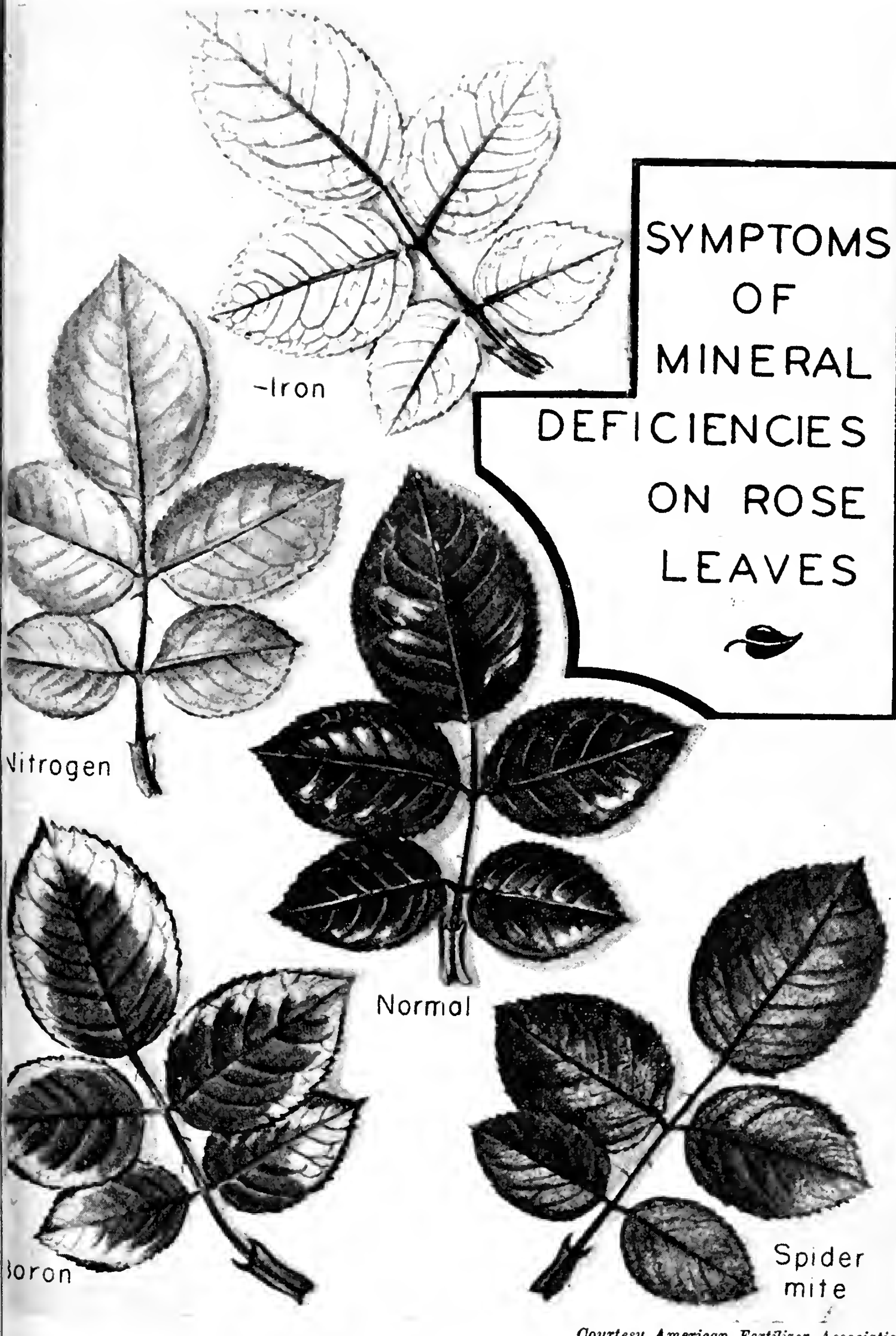
Nitrogen lacking. Leaves sickly green, lusterless.

Normal. All elements available, leaf is rich, healthy green.

Boron lacking. Margins of leaves turn yellow, edges die and turn brown.

Spider mite injury. May be mistaken for deficiency symptom. Light areas on leaf have a stippled appearance.

Virus disease (not pictured). May also be mistaken for deficiency. Leaves mottled with yellow early in season, recover nearly normal appearance later (after blooming period).



Courtesy American Fertilizer Association

more or less emphasis on the different fertilizing elements. For example, a particular plant may respond well to potash so that a higher potash fertilizer such as 5-10-10 might be a better choice than a 5-10-5 which contains proportionately only half as much potash. Generally speaking, however, any one of the above complete fertilizers will do a good job as an all-purpose plant food source.

Organic Material

Most commercial fertilizers are straight chemical fertilizers containing little or no organic matter. It is assumed, and certainly hoped, that all gardeners recognize the universal need for organic matter in the soil. Further, every effort should be made to maintain adequate amounts of organic matter by supplying it through composting or other means.

Application

The figure on page 9 illustrates how fertilizer may be applied to plants. A small handful can be spread in a ring around each plant. This amount (about 2 ounces) should then be worked into the soil. We hear sometimes about over-fertilization with resultant burning or damage to the plant. It is certainly true that fertilizer burning can occur from large overdoses and careless application. However, the tendency of the average gardener seems to be in the direction of under- rather than over-fertilization. Specified rates of application are usually given by the manufacturer (on the bag), or are easily obtainable from your state experiment station. It is difficult to state here rates of application which will be valid in all areas for all plants and shrubs. A few general comments, however, might be helpful.

Lawns

For fertilizing lawns a good practice is to use from 20 to 40 lbs. of a commercial fertilizer such as 5-10-10 or 5-10-5 or 10-6-4 per 1000 sq. ft. of area. Thus at the 40 lb. rate a lawn of 10,000 sq. ft. (100 ft. x 100 ft.) would require about 400 lbs. Some experienced gardeners prefer to split the application, putting on 200 lbs. in early spring and the other 200 in late summer or fall. Limestone can be applied simultaneously if desired or necessary, at about 40 lbs. per 1000 sq. ft. Actually limestone can be applied at any time and need not be watered in. The fertilizer, however, should be watered in or, if one is a good weather forecaster, applied when rain is imminent. Never apply the fertilizer to wet grass because burning may result. A hand fertilizer spreader is accurate and handy for doing the job. It can be useful, also, in seeding lawns or spreading certain lawn insecticides, and even in transporting small shrubs here and there. When used for transporting, a board cut to fit should be placed over the rotating, spreading mechanism in the bottom of the spreader. It is good practice to hose out and dry the spreader after use because certain fertilizer materials tend to corrode the metal parts if in contact over an extended period.

Evergreen Shrubs

Evergreen shrubs, both narrow- and broad-leaf, can be effectively fertilized with 2 to 4 lbs. of 10-6-4 or other complete fertilizer per 100 sq. ft. of bed area. As in the case of lawns the application is best watered in. Application may be split if desired, one half in the spring and one half later on in the season.

Rhododendrons and azaleas can be fertilized in the same manner. In addition one should watch for iron deficiency symptoms similar to that shown on a rose leaf on page 7. Ferrous sulfate at a rate of about 1 oz. per gallon of water is often used to overcome this problem. New organic iron complexes called "chelating agents" are also being used for this iron nutritional problem. (See P&G, Winter '54-55, p. 258.) Rhododendrons and azaleas tend to do well in an acid soil (pH 4.5-5.5) so alkaline materials such as limestone are to be avoided; they counteract the acidity. This is also the reason why acid peat, decayed apples, oak leaves, etc. are used on these plants.

Ammonium sulfate (20.5% nitrogen) is often used because in addition to supplying nitrogen it also acidifies the soil. For quickly acidifying alkaline soils for rhododendrons and azaleas, aluminum sulfate or elemental sulfur are probably best. Neither of these last two materials has any fertilizer value (be sure to see P&G, Winter '54-55, p. 261).

Garden Flowers

All kinds of garden flowers have at least one thing in common. They must be fed. Liberal use of a 5-10-10 or 5-10-5 fertilizer will reward him who applies it. If new beds are being prepared, 2 to 3 lbs. of fertilizer per 100 sq. ft. broadcast over the surface and mixed by spading is a good practice. Banding existing plants as previously mentioned is also a good method of fertilizing. For small plants, daffodils, dahlias, and the like, about 3 ounces spread in a band and worked in may be adequate. Large vigorous rose bushes might require as much as 6 to 8 ounces. We usually band our roses in two applications, one half in early spring, the other half during the summer.

Obviously the above comments on fertilizer amounts and application are very general. Soil conditions will determine which and how much fertilizer to use. The main point here is to put the emphasis on the fact that every growing plant needs food. Commercial fertilizer should be as much a standard item in a gardener's shed as his lawn mower or pruning shears. Indeed, wholesale neglect of good fertilizing practices can eliminate the need for the latter two pieces of equipment.

Commercial fertilizer is by no means a cure-all for all garden ills, but it plays a key role in producing healthier, larger, more beautiful plants; a more luxurious, carpet-like lawn; lush, profuse bloom of flowers; or a bounty of fruits and vegetables that far surpass any grown without fertilizer.

To apply fertilizer to plants in perennial border, spread small handful (about 2 ounces) in ring around each plant and mix carefully into soil.

Courtesy American Fertilizer Association

SLOW-RELEASE NITROGEN FERTILIZERS

Promising new synthetic organic fertilizers release nitrogen to plants over long periods

Paul F. Frese

EIGHTEEN years of scientific research, undertaken by the U. S. Department of Agriculture, state colleges, and the technical divisions of some of the leading manufacturers of agricultural products, have produced for gardeners a revolutionary new form of nitrogen fertilizer. It is a combination of urea and formaldehyde called ureaform, a slow-release material which in spite of its high analysis—as much as 38 per cent nitrogen—will not burn plants, will not leach away with rain or through sandy soil, and will feed plants continually for months from one application.

As supplied by the manufacturer, this fertilizer is clean, odorless, and has a fine, granular texture which makes application both pleasant and easy. It won't cake, nor will much of it dissolve in water. The color is light or white.

Only Small Amounts Needed

Because it is very high in nitrogen, only small amounts are needed to adequately feed lawns, ornamentals, and pot plants. The recommended amount based on a 38 per cent nitrogen content, is from 10 to 20 pounds to 1,000 square feet of turf; 3 pounds to 100 square feet of flower bed or shrub border; and 1 to 2 teaspoonfuls mixed with the soil in a 6- or 7-inch pot.

Nitrogen Released Slowly

Ureaform is a synthetic arganic fertilizer compound which is for the most part insoluble in water. In the soil, however, its nitrogen is gradually converted by soil bacteria to a form which is available to plants. One application can last for 6 to 8 months.

Although nitrogen alone is supplied, nitrogen is in fact the key to pla
growth. Many lawn soils already contai
ample supplies of phosphorus and potas
but periodically these other elements ma
be needed on lawns. Whereas the manu
facturer cannot, as yet, add these elemen
to ureaform nitrogen and leave them t
gether safely in storage, the home ga
dener can mix them and apply them t
gether on the lawn or cultivated area
For some gardeners it may be simpler t
apply the different fertilizers separate
(with a spreader, of course) than it is t
mix them.

Valuable for Lawns

Without question, these "one-sho
urea fertilizers will be especially val
able on lawns. Compared with solub
lawn foods, the new product has man
advantages. Instead of producing quic
succulent growth in spring right aft
application, which lays the lawn open
attack from diseases, the gradual relea
of nitrogen over several months by ure
form fertilizer encourages durable, health
turf which has a better chance of survi
ing through summer heat and drough
Weeds have difficulty in getting esta
lished in a thick, actively growing turf.

The slow-release action of this fertiliz
reduces the danger of burning the law
using recommended amounts. Furthermor
it is non-corrosive and will not rust fe
tilizer spreaders and other equipment.

Lawn-feeding methods now may
changed to better meet the needs of di
ferent kinds of grasses. In cool region
rather than feed in spring, the applic
tion can go on in late fall. In warm r
gions two applications may be require
one in late summer or early fall and a
other in May or June.

ontrolled growth rate obtained with slow-release nitrogen fertilizer. Plant at left ceived no fertilizer; next plant received ½ teaspoonful, the next 1 teaspoonful, and one on right 1 tablespoonful of a slow-release fertilizer.

Cost

The cost for a pound of ureaform ferlizer is considerably higher than that of w-analysis mixed fertilizers, but when e price is compared with that of organic itrogen fertilizer, then there is little dif-rence in value received. Slow-release ertilizers are available under several ade names, among which are Uramite nd Borden's 38. Golden Vigoro contains small amount of ureaform in addition other nutrients.

Use in Greenhouses and on House Plants

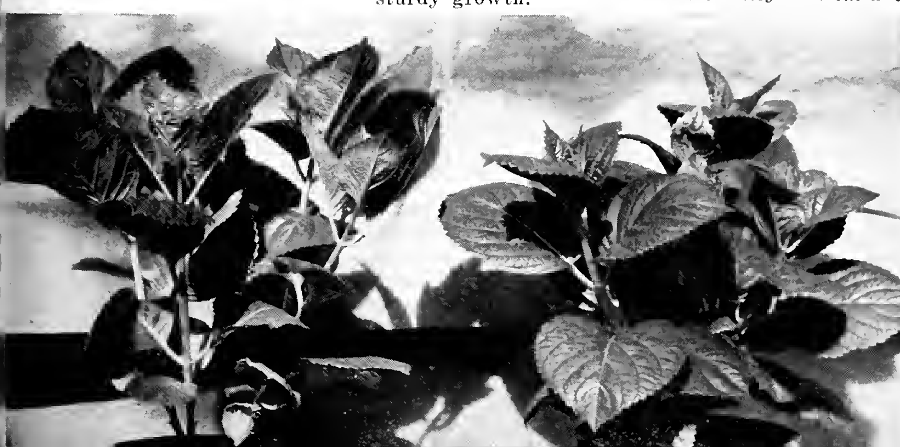
Growers of house and greenhouse lants have reported very favorable re-ılts with this type of fertilizer. When ixed with the soil at potting time, plants espond well to feeding right from the art, but growth continues steadily, lants remain healthy with rich green oliage, and make sturdy growth. Com-iercially grown plants continue to thrive fter purchase. Constant feeding isn't ecessary.

omparison with Liquid Fertilizers

For the last 2 or 3 years much attention has been centered on soluble fertilizers to be applied in liquid form. Now come the new slow-release fertilizers, and the question may arise in the minds of some gardeners whether these are meant to supercede the liquid forms. Actually, the two types of fertilizer fill two distinct gardening needs. Plant food in liquid form is immediately available to the plant; it may be absorbed in a matter of a few hours. These types are therefore valuable where the need for fertilizer is acute, or where a "booster" shot of nutrient is needed, as in transplanting. Liquid fertilizers do not stay long in the ground, however, and after 3 or 4 weeks they are gone. The ureaform fertilizers, on the other hand, last in the soil for months, and during this time furnish a continuous supply of nitrogen to the plants.

While technical data have been gathered on the use of the new nitrogen fertilizer, its broad use has yet to be explored. Home gardeners are almost certain to play an active part in getting at the facts. There is every reason to expect that ureaform nitrogen will become a valuable aid in the garden as a long-lasting fertilizer.

'lant on left was treated with conventional nitrogen fertilizer; plant on right with a low release nitrogen fertilizer. Even release of nitrogen by latter results in compact sturdy growth. *Photos courtesy Du Pont & Co.*



When dug deeply (10 to 15 inches) poor-structured soil will break apart into block-like clods.

LIVING QUARTERS FOR PLANT ROOTS

A picture story of how soil conditions determine root development

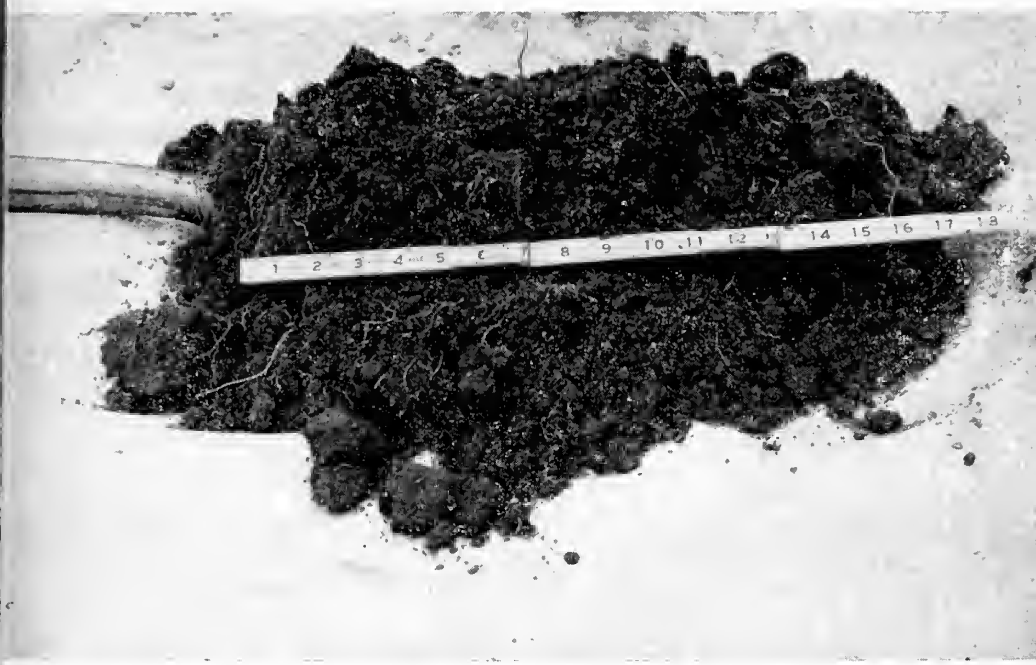
Henry C. de Roo

SOIL is the living quarters of an important part of most plants. Frequently half of a plant or even more, consisting entirely or largely of roots, lives and grows in the soil.

The main function of the roots is to anchor the plant and to supply it with the food needed—nitrogen, potash, phosphorus, and other elements—and enormous amounts of water, all of which come from the soil. The smaller rootlets and hair roots are literally the mouth of the plant.

For most species of plants there is a rather definite relation between root and top growth. It follows that a well developed, healthy root system is essential for the production of a vigorous plant.

These facts are so commonplace that there is danger of forgetting them. Even farmers and gardeners, though wise in the ways of plants, have a habit



Author photos

A moist soil of good structure should come apart in rounded, porous crumbs.

of neglecting the roots. This is quite understandable, however, because most crops are commonly evaluated by the above-ground parts. Beets, carrots, chicory, and turnips are among the few crops grown primarily for their roots.

In spite of the general lack of appreciation of the importance of plant roots, most of our efforts to promote top growth are actually directed to the roots of the plant. Fertilization, irrigation, and most cultural practices affect the roots first. Exceptions, of course, are plant breeding and the control of plant pests and weeds.

It is remarkable how far or deep plant roots can go in search of food and water. The root system of a single corn plant, for example, may occupy 200 cubic feet of soil. On young corn plants, in the 5-leaf stage, 23 roots were counted which, in total, were crowded with 10,000 side roots. Alfalfa roots penetrate as much as 30 feet downward. If all the roots of a single wild oat plant grown under favorable conditions and excavated 80 days after sprouting were put end to end, they would measure approximately 54 miles, as actually has been determined.

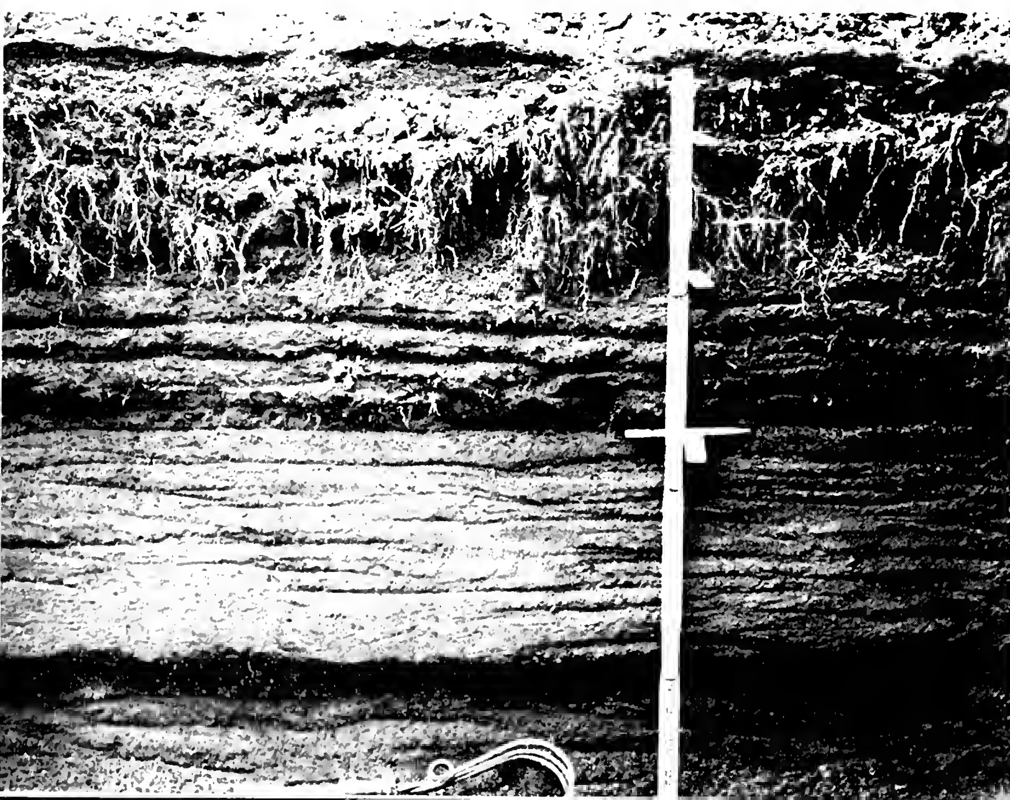
The soil condition needed for good normal root development can be described in general terms as good depth and friability. Such an ideal soil provides a well distributed system of water reservoirs throughout the soil mass, enough air to permit adequate root respiration and microbiological activity, and lots of spaces in the soil into which roots can grow and develop freely.

The photographs which follow show how the character of the subsoil or subtilled soil layers affect root growth.

A "spade test" is one way of getting a look at the soil. A narrow pit is dug with a spade and a slice of soil taken from one of its undisturbed walls. In gently shattering such an undisturbed sample, a moist soil of good structure should come apart in rounded porous crumbs. A poor-structured soil or soil layer will break apart into blocklike clods having flattened surfaces with ver-

To break up hardpan, topsoil is first removed, then hardpan loosened with spading fork as shown here, and big lumps and flat plates of soil broken down. Organic matter may be incorporated. Topsoil is then replaced.

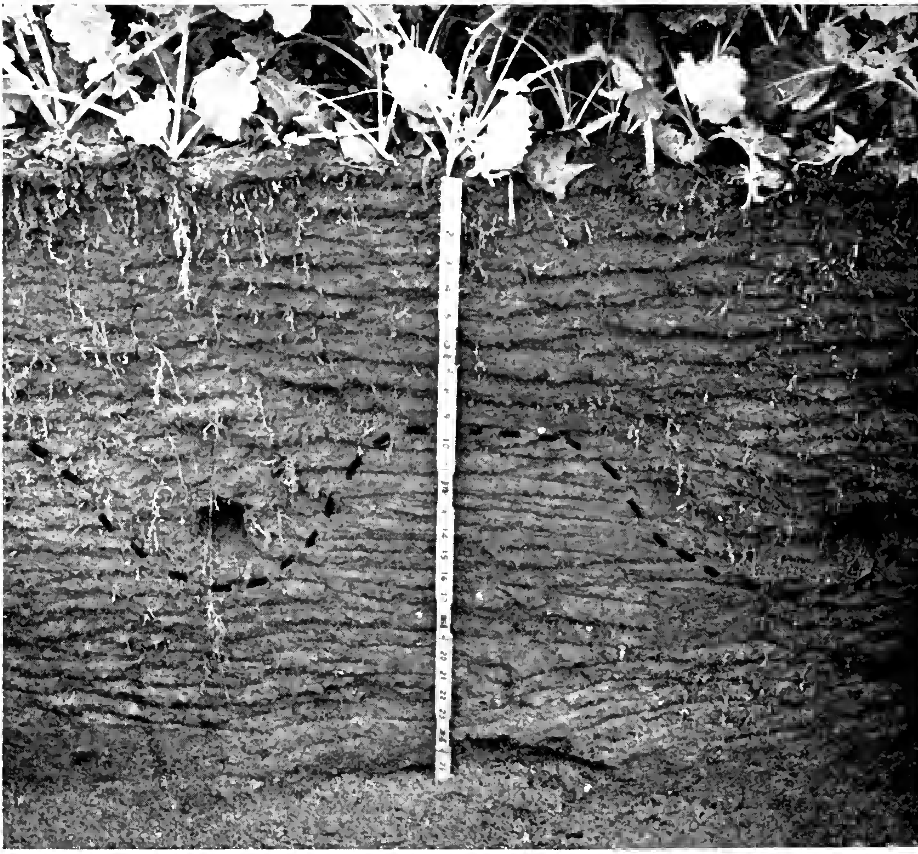
Section down through garden soil near row of plants. Most roots are in upper 6 inches of cultivated layer. Few roots penetrate hardpan (or compaction pan) which here lies 11 to 18 inches below plow depth.



Most of the roots of these plants (rape —*Brassica napus* var. DWARF ESSEX) are confined to the topsoil, the result of badly restricted root space due to a compact subsoil.

Here's how the roots of rape plants will grow when given a chance. Soil in which these plants were grown had been loosened 20 inches deep by hand with a fork as shown on page 14. One requirement for a bountiful harvest is profuse uninhibited root development.

Author photos

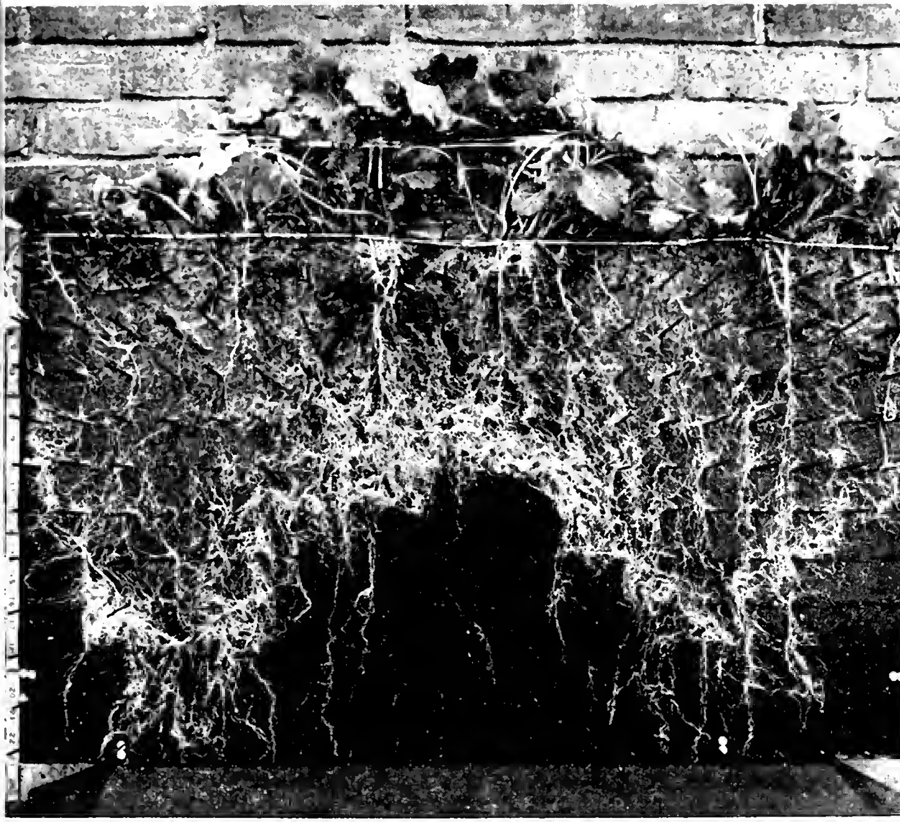


Here the hard subsoil was loosened mechanically by use of a subsoiler in early fall, then seeded with cover crop (dwarf rape). Subsoiler loosens soil to depth of 16 inches in rows 2 feet apart (subsoiler is a machine which pulls piece of metal attached to standard through subsoil and thereby shatters it).

tices more or less sharply angular. Cloddy, lumpy soil with extremely fine, almost invisible pores within the lump is a pretty sure sign of soil structure deterioration or soil compaction. Such a soil is hard to work up into a favorable seedbed and will become waterlogged after every heavy rain. (The soil type involved in these demonstrations is Merrimac sandy loam.)

Soil compaction is caused by pressure on the soil surface, especially when the soil is too wet to work, or to walk or drive on. Careless timing of tillage practices can easily do severe damage to a soil in good physical condition. To cure a bad structure or compaction pan takes a lot of time and effort. In severe cases, the surface soil or a layer of soil at plow or tillage depth may become almost as hard as a concrete floor, as shown in the picture. Use of a bulldozer can bring about such a condition.

What has been shown here on the subject of soil-root relationships emphasizes the importance of examining your garden soil. Dig a little deeper than usual, perhaps 2 feet down, where the soil has a brighter color, and look for differences in color, compaction, or soil depth. Judge for yourself whether or not your soil provides the best conditions for the growth of your plants. If you are not sure, consult an expert. Where soil improvement is too difficult and expensive, the alternative is to change to those plants which can tolerate the soil conditions you have.



When slice of soil with roots (shown on opposite page) is removed and all soil particles washed away, root systems are seen to follow pattern of loosened soil.

Author photos

This is the way author de Roo samples root systems. After inserting pinboard to full limit of its 5-inch long pins, slice of soil 2 feet deep is removed without root displacement. Purpose of steel pins, which are spaced 2 inches apart each way, is to hold roots in position when soil mass is soaked in water and soil washed away. Results of this special technique are evident in other photos.

TESTING THE SOIL

Some suggestions on the where and how of soil testing

Herbert A. Lunt

Soil testing takes some of the guesswork out of gardening. Goodness knows, there are enough unknowns and uncontrollables still remaining to make gardening both a challenge and a gamble. We cannot control the weather, nor can we predict what pests will attack our plantings; but we can know how acid the soil is and what fertilizer it needs. The gardener with this information has won at least half the battle.

Home Soil Testing

Granted the value of the soil test, how does one go about getting it done? First, there's the home test kit. Home testing is interesting—at first, and the results may be satisfactory. The person who remembers his high school or college chemistry and who has the knack for this sort of thing usually does pretty well and is able to keep a fairly good check on his soil. On the other hand, there are limitations to 'do-it-yourself' testing. The chemical reagents may deterioriate and give erroneous results, and lack of experience may lead one to misinterpret the readings. Moreover, the amateur has no way of knowing how his soil compares with others in the area.

Soil Laboratory Testing

The alternative is to send or take the samples to the State Experiment Station soil laboratory or to a reputable private laboratory. Some state laboratories do the testing free; others make a nominal charge. In the case of the private laboratory, the technician usually prefers to collect the samples himself. This procedure has merit and is advisable in many situations. The manner in which the sample is taken has an important bearing on the reliability of the tests; and the opportunity to observe the soil in its natural setting with plants growing on it makes for correct interpretation of the tests when they are made.

Taking a Soil Sample

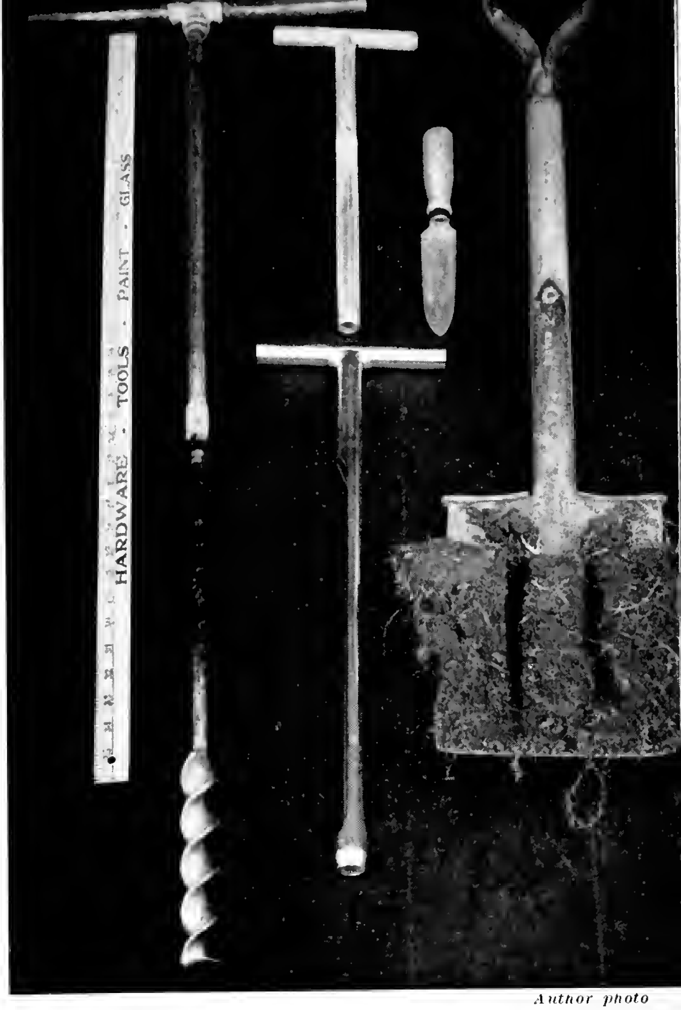
Collecting samples is not difficult but it must be done properly if the tests are to reflect an accurate picture of the soil. Whatever you do, *don't* just pick up a clod from the surface, nor should you sample just one place, even when taken from the proper depth. Remember that the test requires only a little soil, in many cases only a teaspoonful; and that spoonful must represent many hundreds or thousands of pounds of soil.

The proper way to sample is to take a small amount of soil from 10 to 15 different places, going down to a depth of 6 or 8 inches in the garden, and 2½ or 3 inches in the lawn. There are special sampling tools for this purpose but the average gardener can do a satisfactory job with either a long narrow trowel or a sharp spade. If a spade is used, make a thin slice of soil to the proper depth, then cut away the outside portions, saving a fourth or a third of the soil as shown in the photograph.

Put the samples in a bucket, paper bag, or other clean container, mix the whole mass thoroughly, saving ½ to 1 pint of the mixture. If the soil is quite wet, spread it out on clean paper at room temperature and let it dry appreciably *before* mixing.

If any portion of the garden or lawn differs in any respect from the rest, sample that portion separately, using the technique described above. Never include a hilltop and a low wet area in the same sample, for instance. A manured area

Soil-sampling tools. Augers and sampling tubes are helpful but not necessary for home gardeners. Note how soil on spade has been divided with knife; the middle portion is saved for testing.



Author photo

should be sampled separately from one without manure; the north side of the house separately from the south side, and so on.

Label the samples clearly. If the test is to be made in a laboratory, be sure to include as much information as possible about the previous history of the land. Sometimes this information tells as much as does the test itself. Clean pint ice cream cartons or candy boxes make good mailing containers.

When and How Often to Sample

Generally speaking, fall is the best time to sample. Not only is the soil in a more normal condition nutrient-wise after the growing season, but if lime is required it will have all winter to act on the garden plot. Spring sampling is frequently delayed by wet soil, and furthermore, laboratories are always more rushed in the spring, which means greater delay in getting the results back.

Usually it is advisable to test once a year for the first two or three years. After that one should be sufficiently familiar with the performance of his soil to know what it requires, and testing should not be necessary oftener than every second or third year. Many experienced home gardeners have their soils tested only occasionally because—and this is the important thing—they know their soil and what it takes to keep it in a highly productive state. Commercial growers, on the other hand, require testing on an annual or semi-annual basis.

SOIL TESTING LABORATORIES OF THE 48 STATES, 2 TERRITORIE AND 6 CANADIAN PROVINCES

State, Territory, or Province	Department or Institution Performing Test	Address
Alabama	Agricultural Experiment Station of the Alabama Polytechnic Institute	Auburn, Alabama
Arizona	Department of Agricultural Chemistry and Soils University of Arizona	Tucson, Arizona
Arkansas	University of Arkansas	Fayetteville, Arkansas
California	No soil testing service is offered by any public agency.	
Colorado	Agronomy Department Colorado Agricultural and Mechanical College	Fort Collins, Colorado
Connecticut	Soils Laboratory Plant Science Department University of Connecticut	Storrs, Connecticut
Delaware	Agronomy Department Agricultural Experiment Station University of Delaware	Newark, Delaware
Florida	Department of Soils Agricultural Experiment Station	Gainesville, Florida
Georgia	University of Georgia College of Agriculture	See remarks
Idaho	County Extension Service Agricultural Chemistry Department University of Idaho	Boise, Idaho
Illinois	Department of Horticulture University of Illinois	Urbana, Illinois
Indiana	Department of Agronomy Purdue University	Lafayette, Indiana
Iowa	Agronomy Department Iowa State College	Ames, Iowa
Kansas	Extension Service Kansas State College	Manhattan, Kansas
Kentucky	Agronomy Department University of Kentucky	Lexington 29, Kentu
Louisiana	Louisiana Agricultural Experiment Station	University Station Baton Rouge 3, Lou
Maine	Agronomy Department University of Maine	Orono, Maine
Maryland	Soil-Testing Laboratory University of Maryland	College Park, Maryla
Massachusetts	University of Massachusetts Fertilizer Control Laboratory Experiment Station or University of Massachusetts Field Station	Amherst, Mass. Waltham, Mass.
Michigan	Soil Science Department Michigan State University	East Lansing, Michiga
Minnesota	Department of Soils Institute of Agriculture University of Minnesota	University Farm St. Paul 1, Minnesot
Mississippi	Agricultural Extension Service Soil-Testing Laboratory Mississippi State College	State College, Mississippi
Missouri	Soils Department College of Agriculture University of Missouri	Columbia, Missouri
Montana	Chemistry Research Department Montana State College	Bozeman, Montana
Nebraska	Agronomy Department College of Agriculture	Lincoln 1, Nebraska
Nevada	Department of Soils and Plant Nutrition University of Nevada	Reno, Nevada
New Hampshire	Agricultural and Biological Chemistry Department University of New Hampshire	Durham, New Hampshire

(In addition to these laboratories numerous private laboratories offer soil testing services)

ould application be le directly, or through County Agent?	Fee	Remarks
nty Agent	$1.00	
ferably through nty Agent	no fee for Arizona residents	
nty Agent	none	Another soil-testing laboratory is located on the Cotton Branch Experiment Station at Marianna.
nty Agent	$1.50	
ler	none	Soil sampling tubes secured through County Agents or directly from Laboratory. Reports are sent to person sending sample and to County Agent.
ler	no fee for Delaware residents	
ferably through unty Agent	none	
ner	none	Soil-testing laboratories located at: Georgia Experiment Station, Experiment, Georgia; Coastal Plain Experiment Station, Tifton, Georgia; College Experiment Station, Athens, Georgia; Georgia Mountain Experiment Station, Blairsville, Georgia. Also a mobile unit.
unty Agent	varies from none to $1.50 depending on test	Counties in Southern Idaho provide some soil tests through their own County laboratories.
ectly	$1.00	Floriculture Division Laboratory handles all lawn, garden and greenhouse soil samples. Laboratory in Agronomy Department tests only field soils. Farm Bureau Laboratories in many counties also test field soils.
her, preferably through unty Agent	50c	
unty Agent	$1.50	Branch laboratory at Cedar Rapids, Iowa.
unty Agent	$1.00	Many counties have local soil-testing laboratories. Farmers are urged to use these where available.
unty Agent	50c-85c	Many counties have local soil-testing laboratories. Farmers are urged to use these where available.
unty Agent	none	
her	50c	
unty Agent	none	
e remarks	none	Directly for complete test. To County Extension Service for pH test.
ther, preferably through ounty Agent	50c	Also 54 County Extension Laboratories.
ther	$1.00	
ther	none	Also branch laboratory at Truck Crop Experiment Station, Crystal Springs, Mississippi and several County laboratories.
ounty Agent	50c-$1.50	Also 98 County soil-testing laboratories.
ounty Agent	$2.50	
ounty Agent	$1.50	
ounty Agent	none at present	Fees may be charged at a later date.
referably through ounty Agent	$1.00 for two samples (minimum) 50c for each additional sample	

SOIL TESTING LABORATORIES (Continued)

State, Territory, or Province	Department or Institution Performing Test	Address
New Jersey	Soils Department Rutgers University	New Brunswick, New Jersey
New Mexico	Agronomy Department New Mexico College of Agriculture and Mechanic Arts	State College, New Mexico
New York	Soil-Testing Laboratory Agronomy Department Fernow Hall Cornell University	Ithaca, New York
North Carolina	Soil-Testing Division N. C. Department of Agriculture	Raleigh, North Carolina
North Dakota	Department of Agronomy N. D. Agricultural College	Fargo, North Dakota
Ohio	Agricultural Extension Service Ohio State University	Columbus, Ohio
Oklahoma	County Soil Testing Laboratory Local County Agent's Office	
Oregon	Soil-Testing Laboratory Soils Department State Agricultural College	Corvallis, Oregon
Pennsylvania	School of Agriculture Pennsylvania State University	University Park, Pennsylvania
Rhode Island	Department of Agriculture University of Rhode Island	Kingston, Rhode Island
South Carolina	Clemson Agricultural College Soil-Testing Laboratory	Clemson, South Carolina
South Dakota	Soil-Testing Laboratory South Dakota State College	Brookings, South Dakota
Tennessee	Department of Agronomy Agricultural Extension Service University of Tennessee	P. O. Box 1071 Knoxville 7, Tennessee
Texas	Soil-Testing Laboratory Agricultural Extension Service	College Station, Texas
Utah	Utah State Agricultural College	Logan, Utah
Vermont	Soil-Testing Laboratory Regulatory Service College of Agriculture Morrill Hall University of Vermont	Burlington, Vermont
Virginia	Agricultural Extension Service Virginia Polytechnic Institute	Blacksburg, Virginia
Washington	Agricultural Extension Service Washington State College	Pullman, Washington
West Virginia	Agricultural Experiment Station West Virginia University	Morgantown, West Virginia
Wisconsin	Department of Soils College of Agriculture University of Wisconsin	Madison 6, Wisconsin
Wyoming	Department of Agronomy University of Wyoming	Laramie, Wyoming
Territory of Alaska	Agricultural Experiment Station University of Alaska	Palmer, Alaska
Territory of Hawaii	Agricultural Experiment Station University of Hawaii	Honolulu, Hawaii
Alberta	Department of Soil Science University of Alberta	Edmonton, Alberta
British Columbia	Soil-Testing Unit British Columbia Department of Agriculture	Victoria, British Columbia
Manitoba	Department of Soil Science University of Manitoba	Winnipeg, Manitoba
Nova Scotia	Division of Soils Nova Scotia Agricultural College	Truro, Nova Scotia
Ontario	Department of Soils Ontario Agricultural College	Guelph, Ontario
Quebec	Soil-Testing Laboratory Agricultural College or Soil-Testing Laboratory Canadian Industries Limited	St. Anne de la Pocatiere, Queb 3032 St. Catherine St. E., Іntr Quebec

(In addition to these laboratories numerous private laboratories offer soil testing services)

hould application be de directly, or through County Agent?	Fee	Remarks
inty Agent	none	
inty Agent	varies with test requested	
inty Agent	$1.00	Samples from greenhouses should be sent to Soil-Testing Service, Department of Ornamental Horticulture, Plant Science Building, Cornell University.
unty Agent	none	
ectly	$1.00	No determinations are made for nitrogen or potash.
unty Agent	$1.00	
unty Agent	50c-75c	
eferably through unty Agent	up to $2.50 depending on test	
unty Agent	$1.00	
her	none	
eferably through unty Agent	none	
rectly	$1.50	Obtain materials and directions from County Agent.
ther	50c	
rectly	$1.00	
ther	$1.00	
ther	35c per sample	Obtain materials and directions from County Agent.
ounty Agent	none	
ounty Agent	$2-$3 per sample	Obtain materials and directions from County Agent.
ounty Agent	none	
ther	25c-$1.00 depending on test	
ounty Agent	none	
ther	none	
ounty Agent	none	
	none	
	none	
	none	
	none	
	none	
irectly	none	
irectly	none	

LIMING GARDEN SOILS

To correct acid conditions

John B. Smith

GEORGE WASHINGTON used marl to lime his acid Virginia soils. Our European ancestors used chalk, marl, and other materials, but the practice was very sporadic in this country until the current century. It is now common knowledge that soils are acid in many regions having sufficient rainfall for plant growth because the basic (alkali) chemical elements —calcium, magnesium, sodium, potassium, etc.—have been leached away, leaving more of the acidic elements. Limestone soils are less affected than others, but even these eventually become acid in the upper layers.

Just why acid soils injure many kinds of plants is not fully known: deficiency of calcium and magnesium, toxicity from aluminum and manganese, inactivation of phosphates, disturbance of beneficial microorganisms, or all of these together may be contributing factors. Acid injury need not trouble, however, since liming materials are a simple cure, and easy to use.

Measuring Acidity

Recording acidity in pH units has advantages in science, but is somewhat confusing to the layman, for the pH scale is an exponential series rather than a straight arithmetic one. A pH of 7 indicates a neutral soil, and the acidity increases rapidly as the numbers are smaller. Experience has shown that growers soon associate needs with pH values, and that only changes greater than a half-unit are important. Furthermore, experience has shown that as much limestone is needed to change from pH 6 to 6.5 as to raise pH 5 to 5.5, because of slower action where the acidity is less. The entire range for soils is from around pH 3.5 in swamp peats to about pH 10 in alkali soils of arid regions.

Probably there is a best pH for each plant species, but it is fortunate that most kinds of plants will make reasonable growth over a considerable range. A low pH is disastrous for garden beets, as is shown in the illustration. Some other crops in this group are spinach, lettuce, cauliflower, onions, and peas among the vegetables; alfalfa and clover among forage crops. At the other end of the scale, rhododendron, azaleas, laurel, blueberries, and a few other species require a low pH. Most crops, including flowers, are like the corn in the illustration on page 25. The plants labeled "check" are on soil that is believed to have once been a cornfield of the Narragansett Indians and that has never had fertilizer or lime. The NPK soil has had moderate fertilization for more than 40 years, but no lime. The NPKL soil had the same fertilizer and was limed to neutrality (pH 7), but has been allowed to develop moderate acidity. The unfertilized, unlimed corn is a failure, but the other treatments produced a fair crop. More lime would be expected to increase the yield, for pH 6.5 is usually recommended for all such crops. Most flowers, except the rhododendron group, are also in the pH 6.5 group.

Diagnosing Soil Acidity

Soil acidity is not easily diagnosed from the appearance of a soil or the plants grown. The best procedure is to arrange for a professional soil test by a state or private laboratory engaged in that work. (See page 20.) The importance of a clear understanding of the relationship of soil acidity to other factors is illustrated by the fact that Irish potatoes may yield best at pH 6.5 but are grown at pH 5.5 to help control the scab organism.

University of Rhode Island

Effect of liming and fertilizing on corn. Plot marked "Check" never fertilized or limed, pH = 5.1; plot marked "NPK" well fertilized for many years but never limed, pH = 5.2; plot marked "NPKL" fertilized and limed too, pH = 5.6.

Liming Materials

There are many kinds of liming materials, but limestone taken from a quarry and ground is the most common. Fine grinding is necessary for rapid and complete action, so the usual specification is that 50 per cent of the product shall pass a 100-mesh sieve. Ordinary or calcic limestone consists largely of calcium carbonate. Magnesic or dolomitic limestone is a special type containing considerable amounts of magnesium carbonate replacing part of the calcium carbonate of calcic stone. It is preferred as it supplies both calcium and magnesium as well as neutralizing soil acids.

Application

There is no formula for rates of application that applies to all soils, for this depends on the quantities of clay and organic matter; the heavier the soil, the more liming material.

The limestone should be mixed with the soil. Spading in to 7 or 8 inches is ideal for small gardens. For larger areas, it is best to plow or spade in one-third of the lime and cultivate in the remainder. This procedure applies to construction of lawns, but for growing turf, only broadcast applications are possible. These help, but act more slowly.

Liming can be overdone, but this is unlikely if guided by soil tests. A pH of 7.5 is a danger sign. Damage from too much lime can be overcome for some crops by the use of borax and manganese. In other instances, it may be necessary to acidify the soil with sulfur. The local soil-testing laboratory will be competent to advise.

A last word—liming is not permanent, and a retest is necessary after a 2- or 3-year interval.

RULE-OF-THUMB FOR APPLYING LIME

To increase the pH by one unit, for each 1000 square feet of area to be treated add

35 pounds of fine limestone for very sandy soils
50 pounds of fine limestone for sandy loams
70 pounds of fine limestone for loams
80 pounds of fine limestone for heavy clay soils

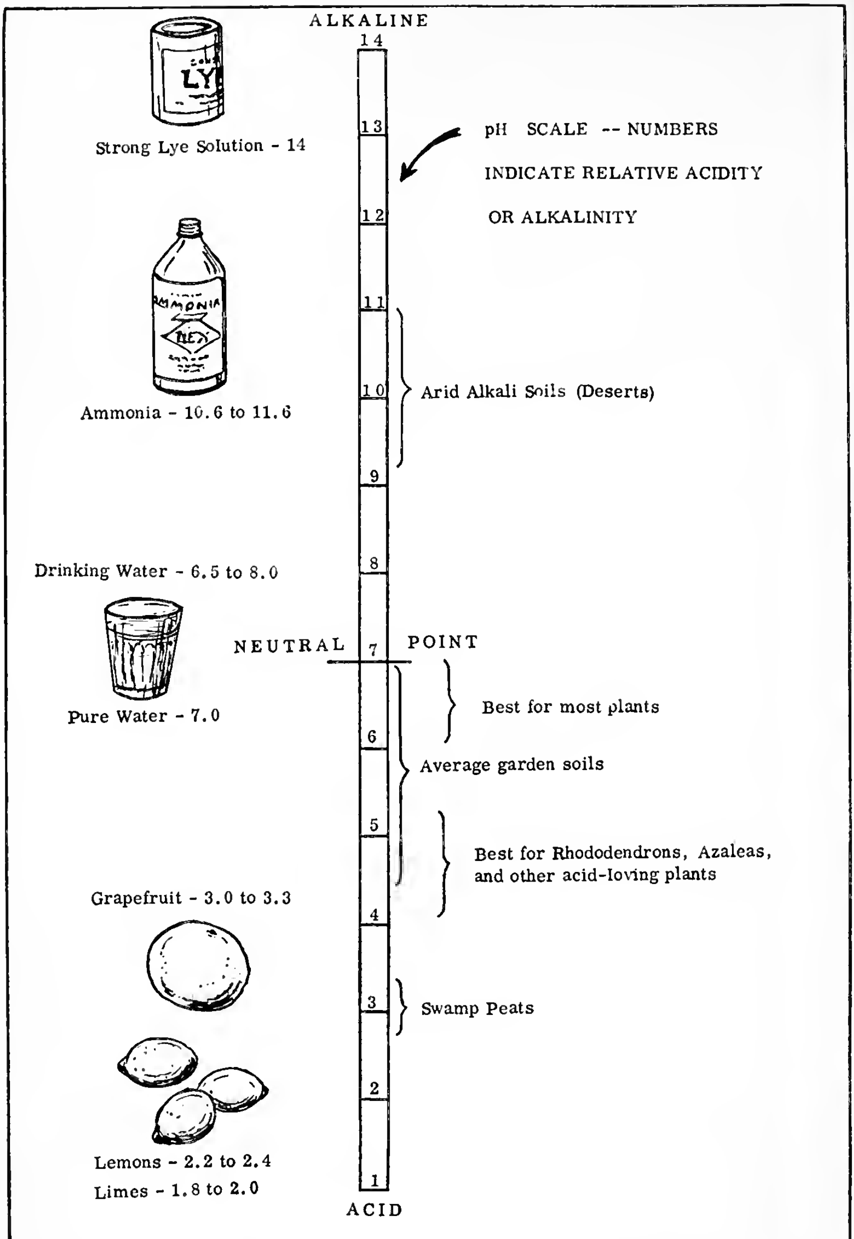


Chart of pH scale (numerical scale to indicate degree of acidity or alkalinity) showin[g] approximate pH of some common materials and range of pH in soils.

WORKING YOUR SOIL

Methods and materials for improving soil workability

Firman E. Bear

EVERYONE who works with soil likes to pick up a handful of it and let it dribble through his fingers. And he can tell by this whether or not it has good working quality or "tilth." This is important to a gardener—it is even more important to the roots of the plants that are growing in it.

Loams—Why They Are What They Are

Loams are naturally endowed with good working quality. This is because they are made up of a well-balanced mixture of large, medium, and small particles—known as sand, silt, and clay, respectively. Such soils stay in good condition no matter how badly they are abused by man, within reasonable limits.

However, the physical makeup of many soils is far different from that of a loam. But such soils can be made into "loams," where the word does not refer to their content of sand, silt, and clay, but merely to their working quality. Thus we have natural loams and "made loams." The working quality of either type can be maintained and improved, or impaired, according to the care given it.

Left to Nature and allowed to run wild, well-drained soils tend to take on the characteristics of a "loam," no matter what their make-up as to size of particles. This good working quality is acquired as a result of the binding action of plant roots and of the microorganisms that decompose soil organic matter. The dead material on which these microorganisms work may have been derived from roots, stalks, leaves, twigs, or the whole bodies of plants, including even large trees.

Two other agencies operate to improve the working quality of soils. One is the sun, with its drying action, assisted by dry winds and by plants. When soil moisture is reduced almost to the vanishing point, the finer clay particles are drawn into granules that are so stable they may remain as such throughout the remainder of the crop season. Another agency, having much the same effect, is the temperature. When it drops low enough to freeze the ground to some depth—again a drying process—the soil tends to break up later in good working condition.

In addition there is the ever-present earthworm which eats its way through the soil, consuming the organic matter as it goes and leaving a slimy residue behind to coat the soil particles. This serves to bind them together on drying in much the same way as do the gelatinous materials developed by soil microorganisms. And the earthworm leaves aeration channels that have value in themselves, especially on heavier types of soil.

The workability of soils can be improved by the incorporation of plant refuse, as such or in composted form. To this refuse or compost can be added peat, sawdust, manure, or a variety of other organic materials. The cruder types can first be used as mulch, and be worked into the soil later. Some enthusiasts claim to have obtained very good results by simply using heavy organic mulches without incorporating them in the soil. In general, however,

A good way to improve workability of soil is to spread compost on surface, then work in to a depth of 8 to 10 inches.

it is considered more satisfactory to work the material at the surface in to a depth of 6 to 8 inches.

Ideally, after the organic matter is spread on the ground, it should be disked in and then plowed (if plowing is needed). For small gardens it can be incorporated by hand, though this involves hard work. It can be worked in to a depth of 3 or 4 inches with a cultivator, then turned with a spade, shovel, or spading fork. In turning under organic material, care should be taken not to turn the soil completely upside-down, but rather at an angle wide enough to just cover the surface material.

Effect of Cultivation

But we soon arrive at the point where something is to be planted. Whether we use a plow, harrow, and cultivator, or a spade, rake, and hoe, we begin to destroy the good working quality that has been built up in the "made loam." Working the soil stimulates rapid decomposition of soil organic matter. The shearing action of the several implements is even more serious, because it results in reducing the soil granules or aggregates to ever finer particles. With continued cultivation the soil tends to return to its original state, i.e., the state it was in before the granules had been developed in it. Working soil while it

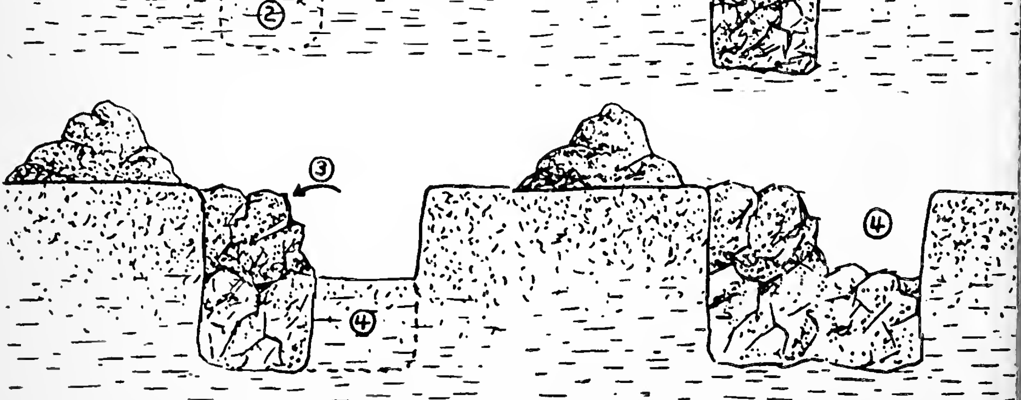
Cover crop of winter rye being turned under with spading fork. Cover crops are easier to work into the soil if not allowed to grow quite so high.

In turning under green manures (cover crops) or other organic materials, soil should be turned at an angle, not completely upside down. In short, organic material should not be completely buried!

Roche photos

Roche

Double digging is useful for soils having heavy subsoils. Trench 6 to 8 inches deep and 8 to 12 inches wide is dug along one edge of plot to be worked. Soil from this trench is set aside (1). Subsoil in trench is spaded (2). Second trench is dug in adjoining strip, the soil being used to fill the first trench (3). Subsoil of second trench is spaded (4). Process is continued clear across plot, topsoil from first trench being used to fill last one. Organic matter, fertilizers, etc., can be worked into topsoil and subsoil during progress of spading.



is too wet speeds up the rate of deterioration.

The shearing action of tillage tools, including the wheels of implements that may be run over the land, is now recognized as a very important factor in destroying the good working quality of soils. The modern tendency is to reduce tillage operations as much as possible. Use is made of weed killers and organic mulches in place of cultivators. Yet some cultivation is essential for best results, notably in the early part of the growing season.

Rotary Cultivators

Some years ago almost everyone was intrigued by the seedbeds that were being produced by a rapidly rotating finger-type of implement that beat the soil up into what looked like perfect condition. Crude organic matter was broken up and thoroughly mixed with the soil. Clods were shattered and the whole soil mass, to a depth of 6 or 8 inches, was made loose and fluffy.

It was soon discovered that a soil that had been so worked tended to develop a hard crust, and to break up into clods when cultivated. Now these rotating devices have knives instead of fingers. They slice rather than beat their way through the soil, and they operate at much slower speeds. Thus the soil is prepared for planting without such serious loss of natural working quality.

Lime and the Workability of Acid Soils

Lime can be made to play an important part in improving the working quality of an acid soil. By its right use the activities of both the soil microorganisms and earthworms can be greatly stimulated. Unfortunately many gardeners tend to overdo liming. The only correct way of regulating the amount of lime applied to a soil is by testing the soil. What is ordinarily aimed for around the yard and garden is a *slightly* acid condition, described in scientific terms as a pH value of about 6.5 (see page 26). Pulverized limestone is the commonest and one of the best of the materials used to correct soil acidity. For rates of application see page 25.

Fertilizers and Workability

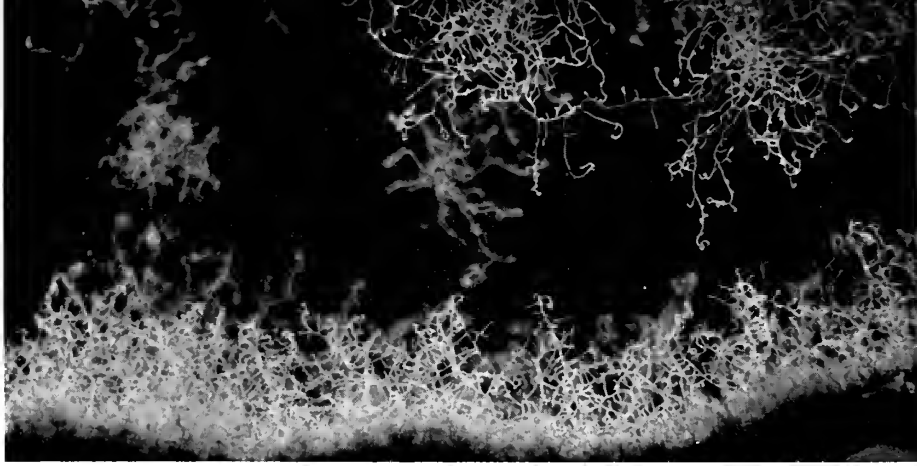
Fertilizer also is important. Well-fed plants have well developed root systems and on dying, leave large amounts of residues in and on the soil for making into compost. The roots are readily and naturally composted inside the soil.

Gardeners enjoy working the soil and getting it into what is called "good condition." There is nothing wrong with this if some means is found of overcoming the damage that is done. The best method is to add organic matter to the soil. Or advantage can be taken of some of the modern soil-conditioning chemicals (see page 64).

Organic Matter

The sources of organic matter for the soil are the bodies of plants and the bodies and excreta of animals. Such things as autumn leaves, manure, a dead bird, or a rotting tree all contribute their quota to the soil. From the standpoint of the practical gardener, not all of the sources have equal value. The following are some of the common organic materials which gardeners can add to the soil—either directly or after being composted:

- Leaves raked up in the fall
- Dead weeds and plants removed in cleaning up the garden
- Lawn clippings
- Sawdust and wood chips
- Kitchen scraps (vegetable wastes and meat scraps)
- Barnyard manures
- Green manures — crops such as winter rye and such legumes as clover, vetch, etc. which can be turned under



Courtesy General Biological Supply House, Inc., Chicago

This thread-like organism (*Streptomyces griseus*), originally discovered in soil and here shown growing in culture, is source of the antibiotic streptomycin.

THE LIVING SOIL

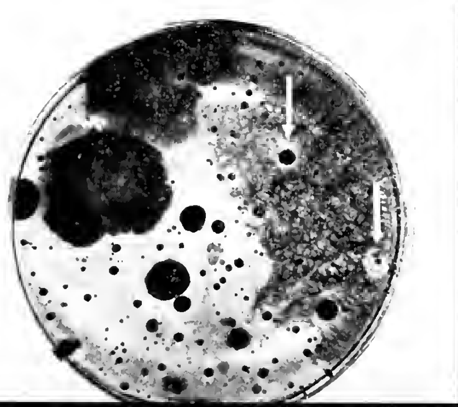
Discoverer of the antibiotic chloromycetin tells of the amazing microscopic creatures that dwell in the soil

Paul R. Burkholder

WHAT is soil—animal, vegetable, or mineral? The answer is, it is all three. Soil is not merely inert mineral matter with a variable admixture of organic stuff, water, and air. It is alive with teeming hordes of small creatures belonging in both the animal and vegetable kingdoms. Great numbers of tiny animals—protozoa, insects, and worms—are at home in soil, and so also are the little plants—algae, bacteria, fungi, and actinomycetes. This complex population of microbes is busy all the while making a living and bringing about profound changes in the chemical and physical properties of soil.

Colonies of molds, bacteria, actinomycetes from soil growing on nutrient jelly in covered glass dish. Clear areas around some colonies (arrows) shows that they are giving off an antibiotic which inhibits growth of nearby organisms.

Courtesy Lederle Laboratories



Microorganisms which appear to have useful properties are isolated from others and grown as pure cultures in test tubes.

Courtesy Charles Pfizer and Co., Inc.

A Thimbleful of Soil

Not all soils contain the same kinds and numbers of microorganisms. Desert soil supports growth of many spore-forming fungi and actinomycetes, and rich garden loam always contains numerous bacteria. Actual numbers of soil inhabitants may be estimated by making a suspension in water and spreading a small measured amount of this on the surface of a suitable gel medium in a glass dish. After the microorganisms have grown for a day or so, colonies of each kind may be recognized and counted. A thimbleful of soil may contain as many as two billion bacteria, about thirty million fragments of fungi, and perhaps a hundred thousand protozoa. All of these possess peculiar beauty of form and color when seen under a microscope, and almost nobody but the professional microbiologist is aware of their existence.

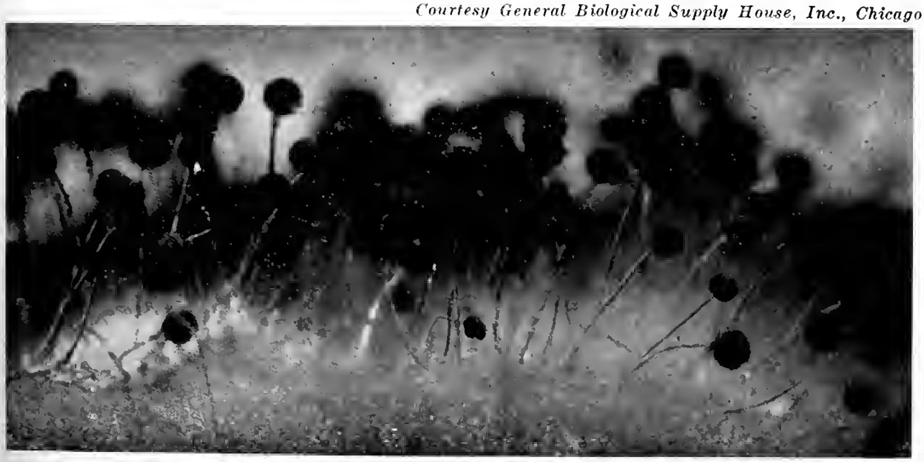
Compost and Microbes

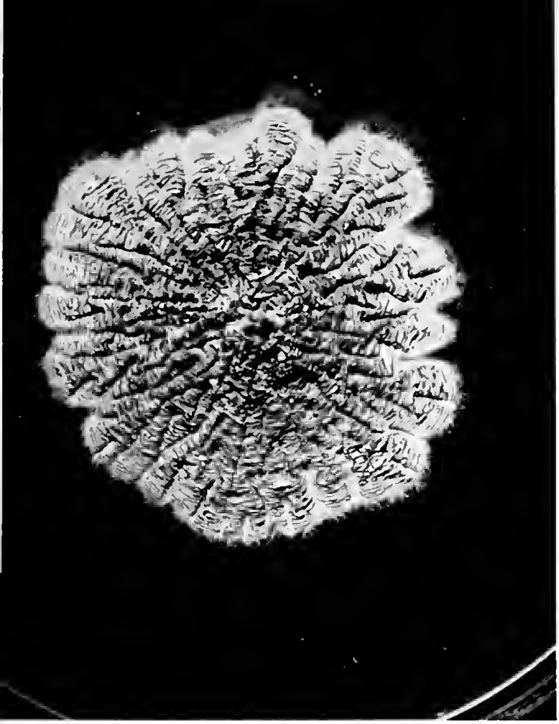
The activity of microorganisms varies with the season of year, being greatest in the spring and fall and least in summer and winter. Moist, well aerated soils support very large numbers of bacteria, especially when organic matter is available for them to feed upon. Addition of compost enormously increases microbial action, resulting in production of soluble substances available for growth of cultivated and wild plants. Composted soils often favor the development of certain kinds of molds and actinomycetes, which can cause reduction in numbers of fungi that produce plant diseases. This has been demonstrated in a striking manner by adding rich compost to flats of seedlings, which then grew luxuriantly, with no damping-off disease; in the same experiment, control plants grown in plain soil all died as a result of fungus rot.

The influence of organic matter in reducing plant pathogens (disease producers) in the soil appears to come about through the growth of certain microorganisms which suppress other microorganisms which are the disease producers. The addition of green manures, fertilizers, and lime exerts many profound effects upon the microbial population, and hence upon various chemical conversions, formation of mineral nutrients, and improvement in physical texture of soils. Were it not for microorganisms, the earth might be covered with rocks and dead debris, and we would be without our richest natural resource—the soil. The little plants and animals quietly and surely participate in processes of weathering the rocks and formation of humus to make soil a living system, ever dynamic and always changing.

This "black mold," magnified about 50 times, is the fungus *Aspergillus niger*.

Courtesy General Biological Supply House, Inc., Chicago





Courtesy Charles Pfizer and Co., Inc.

This flat, wrinkled mass is a colony of an actinomycete (*Streptomyces rimosis*)—half-mold, half-bacterium. It is representative of the form of life used in manufacture of the antibiotic terramycin. About natural size.

Valuable Products of Microorganisms

In addition to the decomposition of inorganic and organic residues by microorganisms, some special bacteria convert nitrogen of the air to a form available for growth of numerous kinds of plants. Still other kinds of bacteria conserve nitrogen by converting ammonia into nitrates, which are then available for plant growth. Some beneficial fungi live as mycorrhiza,* in association with the roots of trees and shrubs. Numerous kinds of bacteria and fungi are widespread producers of hormones and vitamins and soil-eating animals derive benefit without relying upon capsules from the drug store. It has been found recently that most of the fungi and actinomycetes form the blood-enriching vitamin B_{12} (cobalamine) where they live in the soil. It is a strange fact that higher animals and man are utterly dependent upon microbes as the sole source of vitamin B_{12}. As a result of this new discovery, streptomycetes are trained in the laboratory for large scale production of the pink cobalamine, so useful in the prevention and treatment of anemia.

Cooperation and Conflict

Among the crowded communities of microorganisms, ever struggling for growth and reproduction of their kinds, one finds numerous and varying degrees of cooperation and conflict. There is constant competition for living room and food, and each kind of microbe finds in some crumb of soil a special niche

*Mycorrhiza are fungi which live on the roots of many plants, from which they receive at least part of their food. In return they act as water absorbers for their hosts and may supply them with certain useful chemicals.

Author photo

The strands of this actinomycete (*Streptomyces* sp.), magnified 600 times, produce the antibiotic called actinomycin.

favorable for its peculiar way of life. Any garden soil is heterogeneous enough to provide diverse micro-climates and habitats suitable for each specialized kind of microbe. Oftentimes waste products of one kind of organism become the food for another, and exchanges of food materials are continually going on without restraint.

Antibiotics

One of the outstanding scientific developments of this century is based upon a knowledge of microbial antagonisms which exist among certain obscure members of the soil underworld. The discovery of powerful antibiotic substances, synthesized by soil fungi and actinomycetes, has opened up new vistas in modern medicine. Antibiotics, or so-called miracle drugs, all come from microbes, and we are now learning how to exploit them as effective means to combat human and other diseases which were once regarded as incurable. Several hundred different kinds of antibiotics are now known, but only a few are practicable for chemotherapy so far. The quest for new antibiotics continues as we look to the soil for more good microbes with which to fight against the agents of fungal, bacterial, and viral diseases, and cancer. From a knowledge of the living soil comes wealth and health.

Courtesy General Biological Supply House, Inc., Chicago

Filaments of the mold *Penicillium notatum*, magnified about 300 times,—source of the famous antibiotic penicillin.

Courtesy A. C. Lonert

Lockjaw bacteria magnified about 2800 times. The fact that disease producers as well as antibiotic-producers live in the "dirt" gives soil an additional and unique place in the life of man.

ORGANIC COMPOST OR COMMERCIAL FERTILIZER--WHICH?

A soil scientist's answer to a question often asked by gardeners

Emil Truog

WILL we get better crops and more nutritious food and do a better job of conserving our soils if we fertilize with organic composts rather than commercial fertilizers? That is a question some are asking today. What is the answer?

Many careful experiments have demonstrated that the main benefit derived from applying organic materials such as animal and green manures to soils comes from the fertility elements—nitrogen, phosphorus, potassium and others—which they carry. Undoubtedly, the same holds true for organic composts which consist of rotted organic materials like straw, leaves, grass, or even manure itself. These same experiments have also shown that the fertility elements in commercial fertilizers are fully as available to crops as those in organic materials, and in some cases even more so.

Inorganics Not Harmful

Some advocates of "organics only" hold that the fertility elements in commercial fertilizers, having been made through the use of strong acids like sulfuric and nitric acids, or consisting of inorganic salts like potassium chloride, are corrosive or toxic to soil bacteria and earthworms, and even give rise to crops of inferior food value, causing disease in animals and humans. There exists absolutely no scientific evidence to support this contention. Experiments have shown that the application of commercial fertilizers tends to increase the numbers of bacteria and earthworms in soils.

When organic matter rots in the soil through the action of bacteria, its nitrogen is changed to nitric acid, its sulfur to sulfuric acid, and so on. These acids then combine with elements (like calcium) in the soil to form salts, which serve as nutrients for plants. Until the elements present in organic matter are thus changed, they are not available for use by plants. There is absolutely no difference between the nitric and sulfuric acids formed in the soil from organic matter through the action of bacteria and these same acids as used in a fertilizer factory. The same holds for many other chemicals, for example, calcium nitrate or potassium chloride. Thus we see that the form in which plants take up their nutrients is the same whether they are originally supplied as organic material such as compost, or as commercial fertilizer.

Real Value of Compost

It is true that the use of compost adds to the supply of organic matter in soils, and in this way promotes a better physical condition, that is, better aeration and workability of soils, and improved water relationships. Thus their use may be important, especially to the city gardener who has no supply of animal manure and cannot conveniently practice green manuring. For him, the making of compost from leaves, grass and other waste organic materials for application to his small plot of ground is to be recommended.

The farmer in general, however, ca

not cover his large acreage with compost. Sufficient amounts of leaves and other organic materials just do not exist on his farm. Furthermore, the labor cost of doing this would usually be prohibitive, even if the materials needed could be found. He can very profitably use what straw and the like are at hand for bedding, and then apply to his land what animal manure is produced. For the additional amounts of organic matter needed, the farmer must resort to green manuring and the use of the residues left by his crops in the form of roots and stubble. By using lime and commercial fertilizer as needed, and practicing a good rotation which includes legumes, adequate additional amounts of organic matter can be supplied as a by-product of the regular cropping system.

For the city gardener, it may well be advantageous to make some compost for use in improving the physical condition and fertility of his soil, and then to supplement this with some commercial fertilizer. For a farmer with a considerable acreage, the compost way will usually be neither feasible nor economical. The needed organic matter can and should be supplied as a by-product of regular good farming practices, which include application of lime and fertilizers when they are lacking.

SHORT GLOSSARY OF SOIL TERMS

Aggregate—a mass or cluster of soil particles, also called granule or crumb.

Hardpan—a layer of soil that is compacted and cemented by iron oxide, silica, organic material, or other substances. (See page 14.)

Horizon—if a hole is dug in any well-drained upland soil, there can be seen on its walls a series of horizontal layers of soil of varying thickness, color, texture, etc. These layers are called horizons.

Leaching—removal of dissolved materials by water.

Marl—soft, earthy material consisting of a large amount of calcium carbonate with various impurities, alkaline in reaction.

Profile—the succession of horizons from the surface down to and including the underlying rock or other parent material.

Puddle—to destroy the granular structure of a soil.

Topsoil—the surface layer of soil, i.e., the living soil, containing organic matter and teeming with microorganisms.

Subsoil—the part of the soil below top soil and above the underlying rock or other parent material.

Tilth—a general term indicating the physical condition and workability of the soil.

COMPOSTING

Why it is a wise practice and how it is done

George D. Thornton

COMPOSTING is the term used to describe the partial decomposition or "predigestion" of organic residues. It is done before adding the organic material to the surface of the soil as a mulch or incorporating it into the soil as an amendment.

Value of Organic Matter in the Soil

The physical nature of soil may be improved by the addition of organic matter. It adds "body" to sandy soils, increasing their capacity to hold moisture and improving their ability to pick up and hold mineral nutrients added as fertilizer. Such minerals are released for use by growing plants as they are needed.

Heavy clay soils are made fluffy and porous by addition of organic matter. Consequently, a more favorable air circulation is afforded the roots of growing plants. This encourages root extension, thus increasing the feeding zone of the plant as well as providing additional moisture when needed. Organic matter also serves as food for many beneficial soil microbes. The nitrogen contained in organic residues, when added to the soil, is transformed by microbial action into a form available to higher plants.

Why It Is Necessary to Compost Some Organic Materials

Some materials used for composting contain fairly large amounts of protein or other nitrogen-bearing components and decompose readily. In fact the decomposing processes may go on so rapidly that much of the nitrogen and other nutrient elements are lost before they can be used by growing plants. Other materials contain almost no protein, therefore very little nitrogen. These materials decompose very slowly when composted alone. Should they be added directly to the soil they would interfere with the cultivation and subsequent growth of plants.

By combining such variable materials in the compost heap a very satisfactory product is obtained, and more gratifying results are achieved than if either kind of material had been used alone.

Materials for Composting

Almost any plant material may be used to produce a compost. Leaves, lawn clippings, weeds, garden refuse and kitchen wastes, peat, seaweed, green summer legumes, and farm manures are excellent for this purpose. Other materials which are sometimes used, although less desirable, are wood shavings, sawdust, and tree bark.

Green, succulent materials such as legumes, lawn clippings, and green corn fodder decompose more rapidly than dry, mature plant residues. This is due to their higher nitrogen content and the presence of additional moisture in the green plants.

Chemicals Accelerate the Composting Process

Ordinarily it will be necessary to supply additional nitrogen for the microorganisms which cause decomposition. This is especially true when the materials composted are not rich in this

element. Some nitrogen-containing salts which may be added to material being composted do not add to the acidity that is normally produced in decomposition. Sodium nitrate and calcium nitrate are good examples. Others, such as ammonium sulfate and to a lesser extent, ammonium nitrate, do leave an acid residue which must be neutralized by applying a small amount of lime.

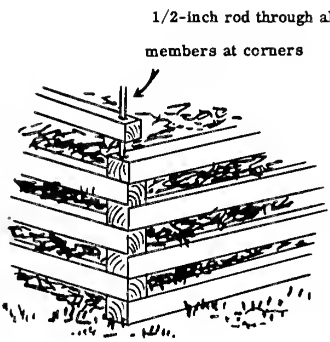
Phosphorus and potassium also are usually added when making compost. A formula often recommended consists of 40 pounds of ammonium sulfate, 15 pounds of superphosphate, 10 pounds of muriate of potash, and 35 pounds of finely ground limestone. One hundred pounds of this mixture is used per ton of residues.

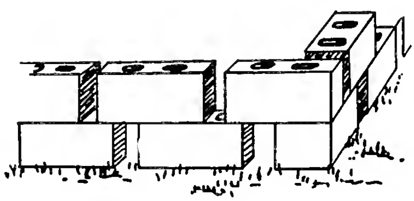
The compost heap is made of convenient size, usually not less than 10 feet square and 3 to 5 feet high. The top should be left flat or with a slight depression in the center to catch and hold rain. If space permits, a long row 8 to 10 feet wide and 3 to 5 feet high makes a convenient compost heap. In either case be sure to leave the top flat or slightly depressed rather than heaped up or rounded.

Composting with Animal Manures

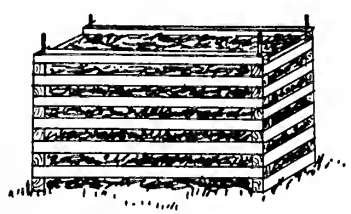
If dry materials are used, water must be applied to insure rapid decomposition. On the other hand, too much water should not be used as it will exclude air and delay the decay processes. A good practice to follow with dry materials such as leaves, grass, and weeds is to make a layer about 1 foot deep, wet it thoroughly with water, and pack firmly. Spread a layer of manure 4 to 6 inches deep over this layer of wet material. Then spread uniformly one quart of superphosphate per 100 square feet of compost. The process is then repeated, making alternate layers of dry material and manure until the compost heap is about 3 to 5 feet high.

Compost made in this way will usually begin to heat after 2 or 3 days. It should be watched carefully at this stage

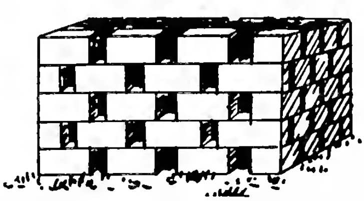




Blocks or bars can be removed for easy access to compost



Compost Bin Constructed of Two-by-twos



Compost Bin Constructed of Cement Blocks
Redrawn from Mary Deputy Cattell, L. A.

Two types of easily built compost bins.

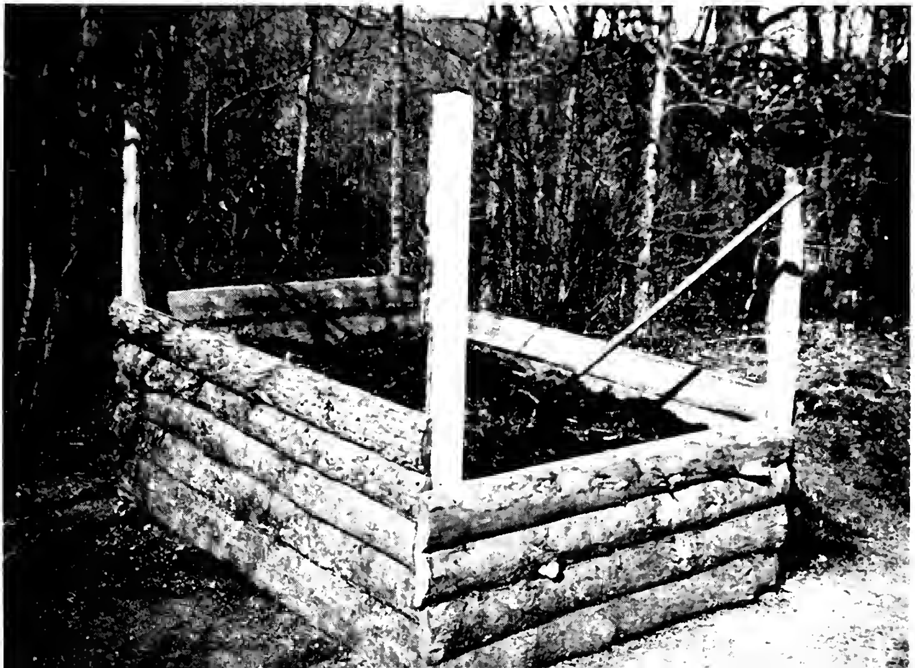
First step in composting is to collect a good supply of leaves or other plant refuse; leaves and soil are two basic raw materials for making compost.

An easily constructed compost bin (see diagrams on page 39 for other types).

Material being composted should be kept moist but not too wet. Adequate moisture is especially important in composting dead leaves.

A simple compost pit. In foreground, screened compost ready for adding to garden soil.

Roche photos



and not be allowed to dry out; neither should too much water be added. The compost should not be disturbed at this stage. After 3 or 4 weeks it may be forked over, mixing the dry and moist decomposing parts to insure a uniformly decomposed material. After another period of 3 or 4 weeks (in warm weather) the compost should be thoroughly rotted and ready for use. Compost prepared in this manner is not only a good source of nitrogen but also an invaluable material for garden crops on any soil and is especially beneficial on sandy soils.

Composting Dry Leaves

Leaves may be made into a good compost even without manure or nitrogen fertilizer, although the addition of these materials makes a better product and hastens decomposition. A simple procedure for composting leaves consists of covering a 6-inch layer of leaves 8 to 10 feet square with a 2-inch layer of soil plus one quart of the mineral formula described above. Alternate the layers, keeping the sides vertical and the top flat. The pile may be built up 2 or 3 feet high. Water should be applied frequently enough to keep it moist but not too wet. Under favorable conditions of moisture and temperature oak leaves composted in this manner will decompose sufficiently for use in 6 months to a year. Leaves from other deciduous trees such as maple, ash, elm, and hickory may be composted as well, and some may even contain a higher ash content and decompose more rapidly.

WHY HAUL IN TOPSOIL FOR LAWN OR GARDEN?

Subsoil can be converted to topsoil—here's how.

In nature, subsoil is being constantly, though slowly, converted into topsoil. Experiments have shown that this conversion can be greatly speeded up by man. At the Ohio Agricultural Experiment Station land from which the topsoil had been completely stripped has been restored to productivity. The subsoil was treated with lime, manure, and fertilizer, and planted to various rotations of crops. Green manures, especially alfalfa, were freely used to aid the conversion.

Home gardeners may be interested in a recent subsoil-to-topsoil conversion that was carried out at the Brooklyn Botanic Garden. The subsoil area (hardpan) to be planted in lawn was first plowed in mid-August. Several loads of well-rotted manure were spread thickly over the plowed ground—about 3 to 4 times as much as would be used for ordinary manuring. Sand, ground limestone, and 5-10-5 were liberally applied, and the whole area well worked over with a rotary hoe. After being allowed to settle, the area was graded and seeded with Merion bluegrass. A vigorous lawn became established by June of the following season. Weeds have been a minor problem, no worse than in any lawn with which we have had experience. The same technique has been successfully employed for preparation of a vegetable garden site on subsoil. One word of caution: add enough coarse sand to insure soil aeration and good drainage.

By way of explanation: subsoil is often as rich as the overlying topsoil in all mineral nutrients except nitrogen and sometimes phosphorus and potash. It is lacking in organic material, and usually has a poor structure. These are the factors which must be dealt with in remaking subsoil. Nitrogen fertilizers must be added, and liming may be needed if the subsoil is too acid. Organic matter (in the form of compost, manure, etc.) is one of the essentials. In clay subsoils synthetic soil conditioners may be very helpful. If possible, soil should be planted to green manure crops for a year or two, but this is not essential.

EARTHWORMS IN YOUR GARDEN

Much has been written in praise of the earthworm; this article sorts out fact from fancy

Henry Hopp

EARTHWORMS can help you in your gardening—if you give them a little care.

1. They can help keep the soil in good tilth (if it is a loam or clay soil).
2. They can help build top soil.
3. They *may* prepare a seed bed without your having to turn the soil in the spring.

The care you must give them is simple but necessary: *cover your garden with a mulch of organic material each fall; rake it off in the spring.* That's all you have to do. During the growing season, do your gardening in the usual way.

A Secondary Soil-building Factor

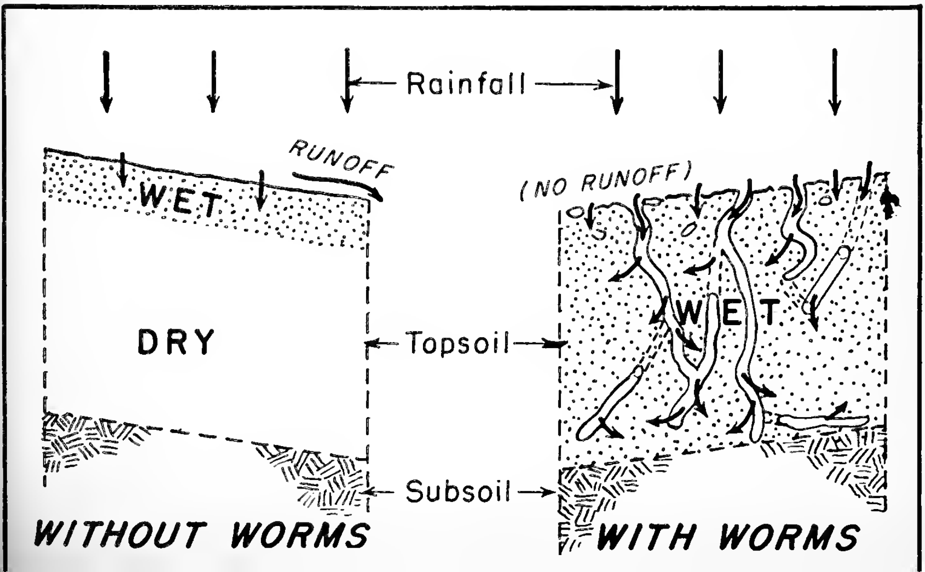
A claim often made is that earthworms are *necessary* for good crop growth. This is not true. The only basic soil necessities for good crop growth are adequate soil moisture, sufficient available nutrients, and air spaces for root growth. A sandy soil, well fertilized and watered, comes closest to having all of these basic properties. Earthworms are of no importance under these conditions.

But most gardens are on heavier soil—loams or clays. Such soils compact readily. When they do, they may lack adequate soil moisture and air spaces for root growth. In order to correct these deficiencies, the gardener depends on *secondary corrective measures.* Earthworms fall in this latter category, and the comments that follow apply to worms in relation to heavier soils.

Effect on Soil Moisture

Most garden soils contain a large proportion of the finer soil particles, such as silt and clay. When cultivated year after year they lose their desirable structural quality. The particles tend to pack together. The soil becomes more like a cement than a sponge: it becomes less able to absorb water; much of the rain runs off the surface instead of percolating into it. A soil that has deteri-

Diagram shows how earthworm channels improve water intake of soil. In absence of channels, water wets soil from top downward, often so slowly that much is lost by run-off. When earthworms are present, water runs down channels and wets topsoil throughout. Run-off is much reduced.



orated in structure will become droughty even though total rainfall is sufficient.

Earthworms are but *one* of several factors that improve this condition by increasing the water-absorbing ability of the soil. During the winter, if the surface of the soil is protected by a mulch, they make numerous casts near and on the surface. These casts resist the pounding action of falling rain drops and keep the surface soil from packing. The earthworms also make a network of channels through the soil and their slimy secretions line these channels so that they are stable when water runs through them. Such channels increase the rate of water absorption by the soil.

Effect on Aeration

Earthworm channels provide some of the passageways for roots to grow in, for roots grow in the air spaces between soil particles, not in the soil particles themselves. When earthworms perforate the top soil and carry organic matter down to the subsoil, roots have an easier time becoming established.

Effect on Nutrients

Another common claim is that earthworms free the chemicals that are in the mineral soil they eat. Actually, there is no real evidence to justify such an idea. However, they do carry surface organic matter down into the soil and, as part of their digestive process, mix it intimately with subsoil particles. This produces humus. *The richness of the humus they produce depends on the kind of organic debris and mineral soil that they have for food.*

Earthworms conserve the nitrogen in the soil by storing it as protein in their bodies and preventing it from leaching during the winter months, when vegetative growth is at a minimum. Then, as the new generation of earthworms comes on in the spring, the mature ones die. The dead bodies disintegrate so that the stored nitrogen is released to the soil during the summer months. The nitrogen becomes available for the growth of crops at that time. The amount of nitrogen released this way was estimated in one study at about 40 pounds to the acre. This is about 1/3 of the nitrogen needed to produce an average crop.

Should You "Plant" Earthworms?

Earthworms are already widely distributed over the country and it is rarely necessary to introduce them artificially in gardens. If there are no earthworms at all in your soil, there is some condition that prevents them from living there. Any worms introduced artificially will likely die. Most gardens already support some earthworms. To build up their number the one thing you must do is to keep the ground covered with mulch during the winter.

There has recently been considerable popular emphasis on introducing "hybrid" or specially bred earthworms for soil improvement. To the best of our knowledge, there are no hybrid earthworms.

Does Fertilizing Hurt Earthworms?

It is a fallacy that chemical fertilizers kill earthworms. In the amounts customarily used in gardens, fertilizers have no harmful effect on earthworms. The fact is that fertilizer is a good adjunct to the soil-improving activities of the earthworms: you will get maximum advantage from the good soil tilth contributed by the earthworms only if soil nutrients are adequate.

Building the Worm Population

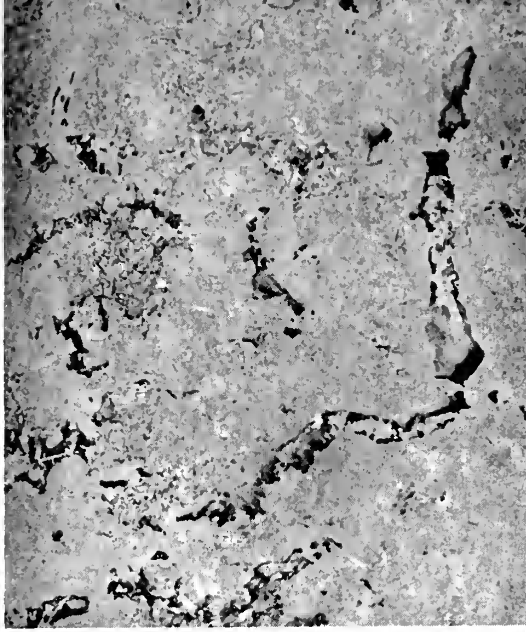
Earthworms are mainly active in the spring and fall, when the soil is cool and moist. Where the climate is not too severe they may remain active all winter. During this time of the year, they need protection on the surface of the soil. Their humus-building activity is largely confined to these periods. At the same time, they granulate the surface of the soil and make it a good seedbed for you to plant in the following spring. Thus, during the cool seasons they help somewhat in restoring the soil tilth that was lost as a result of summer cropping.

If the soil is not mulched during the winter, most of the earthworms will die or go into more protected areas. If the tilth-restoring process is inoperative, further soil decline will take place during the winter, and by spring, the soil is likely to be badly puddled.

The surface mulch that earthworms require during the winter can be almost any kind of insulative material: manure, compost, straw, a mulch of dead grass and weeds, or a winter cover crop which gives a heavy sod. Such materials both protect the worms and give them food. Even a relatively inert material, such as a board, will protect the earthworms, as you can see by looking beneath such a material where it is lying out on a bare field over winter. Of course, boards are not practical for covering a garden; but they do illustrate the wide range of materials that can serve as protection for earthworms during the winter.

During the summer earthworms are relatively inactive, unless the soil is well watered. Earthworms are adapted by nature to this seasonal lull and do not require any help during the summer. You can till the soil in the summer without hurting the worm population.

When organic debris and insulative cover are given earthworms during the winter, they prosper even if the garden is tilled every year. In contrast to unprotected land, soil so protected is well granulated and porous the following spring.

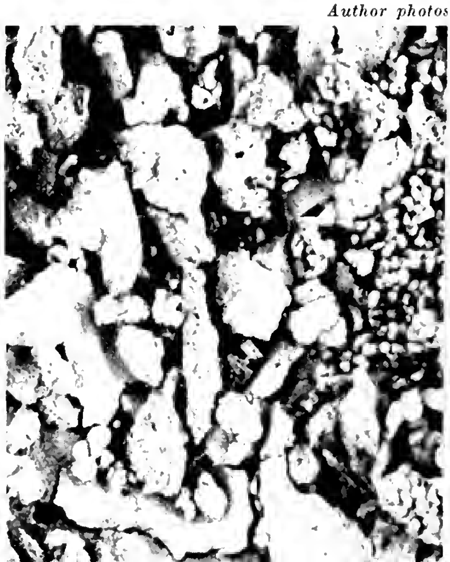


This is a close up of a fine soil that has been much improved in physical condition by action of earthworms. The channels appear as short holes; actually they form a continuous network from surface of soil downward, sometimes to a depth of 2 or 3 feet.

Soil left bare over winter looks like this in spring—compact, with poor structure.

If protected over winter with mulch, structure is good the following spring. Note numerous worm casts.

Author photos



BUILDING UP A SANDY SOIL

An amateur gardener's experiments with compost over a 6-year period

Hugh A. Ward

THE earth is teeming with living organisms, dependent for their food on organic matter. These microorganisms decompose plant and animal residues, and in the process release nutrient elements in available form for plant life. To perpetuate this important process it is necessary to return animal and vegetable wastes to the soil.

The Soil

The experiments here described were carried out on the south shore of Long Island on very sandy loam. Two plots of 1000 square feet each were used as the experimental area. They were heavily cropped with 10 to 15 varieties of vegetables each growing season over a 6-year period. After picking the vegetables for home use, the plant wastes were incorporated in compost heaps, then returned to the soil in the fall and spring. The sandy loam is about 1 foot deep over pure yellow sand, and at the start of the tests was low in such important elements as nitrogen and phosphorus.

Making the Compost

These poor soil conditions were transformed into a high level of fertility by the incorporation of an ample quantity of active compost. This was made by combining 6-inch layers of vegetable matter, i.e., hay, straw, leaves and discarded plant material, with a 1-inch layer of chicken manure together with small amounts of pulverized limestone, rock phosphate, and a sprinkling of topsoil in each layer. The heaps were well moistened but not saturated. Vertical holes 30 inches apart were inserted to allow adequate air for fungi and other organisms to carry out the processes of decomposition. The temperature of the heaps rose within a day or two to 160° F. and stayed there a number of days, then gradually declined to 80°-90° F. at the end of three weeks. The heaps were then forked over. After a lapse of five more weeks a second turning was made, and the compost was then allowed to 'cure' for four weeks, making three months in all for the period of decomposition. The whole mass became a dark brown compost having a slightly woodsy odor.

Application

The compost was applied to the soil at the rate of 20 tons to the acre, and immediately rototilled in to a depth of 6 inches. In a very sandy soil such as this, with a low percentage of built-up granules, rototilling has little bad effect on the structure. The first application was heavy in order to raise the level of fertility as rapidly as possible. In subsequent years the applications were reduced to 10 tons per acre.

Results

The **physical effects** of this treatment were:

1. Evidence of aggregation of the soil grains, resulting in greatly improved soil structure. This was very noticeable in the better tilth and resilience of the soil.
2. Distinct darkening of the soil color, resulting in greater heat absorption.
3. A substantial increase in moisture-holding capacity.

The outstanding **chemical changes**, as shown in the table below, were revealed in the great increases in available mineral elements including nitrate nitrogen. The

transformation was not only rapid, but also maintained a high degree of stability in the supply of plant nutrients. It should be pointed out that in each of the four years preceding the start of the experiment the soil treatment had been a rye cover crop planted in October and plowed under in April. This was followed by a spring application of 5-10-5 commercial fertilizer at a rate of one ton per acre. This is a common soil practice on Eastern Long Island. The following table shows the results of the soil analyses over the years of the experiment.

Effect on Plant Growth

The best measure of a soil's condition and fertility is the growth of plants on such soil, their vigor, and the quantity and quality of the crops produced. On all these counts my vegetables reflected the improved soil conditions indicated by the chemical analyses in the table below. Whether the elements were actually available to plants to the extent shown by the figures is not known, but the final results left no doubt that the method of soil treatment was highly successful.

POUNDS PER ACRE

	At start of experiment	After Compost Application					Considered High
		1st yr.	2nd yr.	3rd yr.	4th yr.	5th yr.	
Phosphorus	**120**	680	710	800	800	800	250-350
Potash	**150**	300	372	600	400	450	150 plus
Nitrate nitrogen	**10**	20	100	60	65	40	50
Magnesium	**100**	350	500	500	475	600	250
pH	**6.4**	7.4	6.9	7.2	6.9	7.1	
Organic matter	*	*	3.64%	3.50%	4.62%	5.98%	3-5%

*Not taken in these two years.

GARDENING IN ARID REGIONS

Usually the two limiting factors in plant growth in a dry climate are water and nitrogen. Normally the average soil is adequately supplied with all of the other essential elements, and in very dry areas, especially on fairly new land, there may even be plenty of nitrogen in the soil for several years.

In some sections, the soils may be deficient in sulfur and will give good returns for applications of gypsum or sulfur. Where the soil has been intensively cultivated under irrigation for a long period of time, deficiencies of phosphorus and other nutrients may develop. It is well to seek and follow the advice of the local county agent or experiment station as to the soil needs in your own area.

Where the rainfall is scanty, gardening without irrigation may be impossible. Water must be used with discretion. Be sure the water available for irrigation is safe to use; if it contains too high a salt content it can cause no end of trouble.

A second precaution is to avoid over-irrigation, especially where the soil is on the heavy side with a tight subsoil.

Irrigation takes time, and water may be costly, but the results are usually very rewarding.

H. A. Lunt

Don't let your builder bury this trash under a future lawn.

PROBLEM SOILS

Most soils respond to proper care and can be made to produce a satisfactory garden or lawn

Herbert A. Lunt

GARDENERS blessed with 'perfect' soil should skip this article. For the rest of us who must struggle with mediocre to poor garden plots there is comfort in the fact that few soils are hopeless, however much they may differ in character and productivity at the outset.

The first step in garden-making is to examine the soil to considerable depth —at least 20 or 24 inches. Too few people take the trouble to look beneath the surface. A perfect topsoil cannot be expected to produce good results if it is underlain by course sand, gravel, heavy clay, bedrock, or miscellaneous debris. The area around many suburban homes, if not poor to begin with, may have been all but ruined by the building contractor.

This article deals with four types of problem soils which may be encountered in eastern United States:

Heavy clay soils are characterized by a degree of compactness which makes cultivation difficult and interferes with the oxygen supply for plant roots. Corrective treatment should include the application of coarse organic matter such as baled peat moss, native peat, compost, bagasse (ground sugar cane stalks), woodchips, or sawdust. Sand also helps and should be used if readily obtainable. Apply these materials rather generously (1- to 2½-inch layer) and work them into the soil with spade or cultivator to a depth of 6 to 8 inches. Repeat the treatment in subsequent years until the

Author photos

These rocks, like builders' trash, mean trouble in future lawn or garden unless most of them are removed before topsoil is spread.

soil is in a good friable condition. Surface mulching with organic matter after the plants are up is good, but to be most effective the mulch material should be worked into the soil sometime during the year.

Light sandy and gravelly soils dry out too rapidly and lack the ability to retain plant nutrients. The addition of clay to sandy soil can do wonders, provided the two soils are thoroughly mixed. However, as such treatment is seldom feasible, it is usually necessary to depend on organic matter for soil betterment. Here the finer-textured peats or peat humus are preferable. Adding peat to coarse sand makes a mixture that is far from ideal, but there will be a gradual improvement over a period of years through repeated cropping, particularly if care is taken to turn back into the soil as much of the waste plant material as possible. Fertilizer applied frequently but in moderately light amounts, together with ample moisture supply will improve plant growth; but don't expect too much the first year or two. The ever-increasing amount of plant roots in such a soil provides desirable qualities not obtainable from the peat or other organic matter alone.

A word of caution. Whenever sawdust, woodchips, or bagasse are used, whether it be on heavy or light soils, it is usually necessary or highly desirable to apply

PEAT MOSS APPLICATION TABLE

One average bale of peat moss (worked loose) contains a little over 7 bushels or about 9 cubic feet of peat. This will cover approximately:

112 square feet (14′ × 8′) of ground to a depth of 1 inch
56 square feet (7′ × 8′) of ground to a depth of 2 inches
38 square feet (9½′ × 4′) of ground to a depth of 3 inches

Author photo

This subsoil is clean and ready for an 8-inch covering of gool topsoil. All debris was removed before grading. Subsoil like this may even be converted into a substitute for topsoil—(see page 42). In any case, keep final soil level well below wood structure (a step in termite control).

additional nitrogen fertilizer to lessen the danger of plant nitrogen deficiency. (The cellulose-decomposing bacteria require nitrogen and they compete with the garden plants for this nutrient). Use 3 to 5 pounds of ammonium nitrate, or its equivalent, for each 100 pounds of dry organic matter applied. Parenthetically, sawdust does *not* make the soil more acid, nor is sawdust toxic to plants. Any unfavorable effect from its use stems entirely from nitrogen starvation.

Soil with much foreign matter such as bricks, plaster board, crockery, B-X cable, wire, and pieces of lumber makes a poor medium for plant roots to grow in. Unfortunately, some builders have no scruples about burying such material under a thin layer of topsoil. Foreign matter, if buried deep enough and not in excessive quantity, may do little harm aside from reducing the amount of living space for plant roots. Otherwise much of it should be removed. Some materials such as builder's lime can be definitely injurious. An excess of lime so upsets the nutrient balance that correction by the addition of potassium and magnesium is virtually impossible. Removal of the lime by mechanical means or massive dilution is about the only remedy.

Another even more serious form of extraneous matter sometimes occurs in the form of buried sidewalks or pavements. Removal is the only remedy in this situation.

Poorly drained soils are unproductive for most garden crops. The installation of tile drains is the most likely method of treatment for this difficulty. In cases where the water comes primarily from adjoining higher land, an intercepting drain or ditch may be all that is necessary. Where drainage is impossible, or at least not feasible, one must be content with growing only those plants which can tolerate 'wet feet.'

Few soils, however poor, are beyond redemption, but no magic formula has yet been devised for converting a poor soil into a productive one. Considerable work and expense may be necessary. Poor soils require more care, and usually more fertilizer and more water than do good soils.

CONTROL OF SOIL-INHABITING PESTS OF THE GARDEN

What to use, how to use it, and precautions for safe handling of fumigants.

C. E. Williamson

Although the soil literally swarms with untold numbers of organisms, most are beneficial or, at worst, harmless, and only a few are injurious. Among the common inhabitants of our garden soils are nematodes, fungi, bacteria, and insects. Some of these attack the plants we wish to grow. They may cause "damping-off" of seedlings, destruction or decay of roots, crowns, and stems, or possibly only stunting and an unthrifty appearance of the plant. If such symptoms appear and plant loss becomes important, the successful gardener will want to control the depredations of the harmful organisms. What insecticides and fungicides accomplish above ground, soil fumigants attempt to accomplish below ground. Unlike most fungicides and insecticides, the soil fumigants now available have no persistent effect. Although fumigated soil may become re-infested, the build-up of pests is usually rather slow. Hence, soil fumigation provides a practical and effective control for destructive soil-inhabiting pests.

At present most commercial soil fumigants are liquids. When applied to the soil, the liquid changes to a gas that diffuses and extends the killing action for some distance from the point of application. Because lateral diffusion is limited to about 12 inches, the volatile liquids must be applied at closely spaced intervals. The powdered or granular solid fumigants can be applied to the surface, then mechanically mixed through the soil. Those made up as wettable powders or emulsifiable concentrates can be applied in a water drench. Because of space limitations, our discussion will be limited to the liquid fumigants.

FUMIGANTS TO USE FOR SPECIFIC JOBS

To control	*Chemical*	*Remarks*
Nematodes	chlorpicrin, dichloropropene mixtures, ethylene dibromide, methyl bromide	
Fungi (including damping-off)	chlorpicrin, formaldehyde, methyl bromide	Dichloropropene mixtures also slightly effective, but only if fumes are confined by a gas-tight cover.
Insects	chlorpicrin, dichloropropene mixtures, ethylene dibromide, methyl bromide	Toxic to many kinds of soil inhabiting insects.
Weed Seeds	chlorpicrin, methyl bromide	Both give excellent control if used under gas-tight cover. Without cover only chlorpicrin gives fair control.

Some Commercially Available Fumigants

Although soil fumigants are sold under a variety of trade names, basically we have only 4 or 5 different chemicals. For the prospective purchaser the active ingredient, which is stated on the label, is the important fact. To avoid confusion and possible discrimination the fumigants will be discussed on the basis of the active chemical. The fumigants most useful to the gardener include the following in alphabetical order: chlorpicrin (trichloronitromethane), mixtures of dichloropropene and dichloropropane, ethylene dibromide (dibromoethane), formaldehyde (technically called formalin), and methyl bromide (bromomethane) either pure or in solution. Because pure methyl bromide is too difficult and hazardous for the average gardener to use, we will cover only the use of methyl bromide in solution. The advanced gardener should consult Experiment Station bulletins or contact his County Extension Service for guidance in using pure methyl bromide.

CHLORPICRIN

Description	*Toxicity*	*Controls*	*Remarks*
Heavy, colorless or pale yellow liquid. Volatile, non-inflammable. Odor sweet and pungent, causes tears to flow, produces nausea. Corrosive to metal.	Quite toxic to plants, should not be applied closer than 6-8 feet. Also toxic to humans but tear gas effect acts as safety feature.	Nematodes Fungi Insects Weed Seeds (best if used with gas-tight cover).	Do not use in closed area where plants are growing. Gas mask sometimes used for application in the greenhouse, not necessary outdoors in slight breeze.

To treat gardens and small areas. Open narrow furrows about 6 inches deep at 12-inch intervals with a spade. Attach a pouring spout to the 1½-pound dispenser bottle and distribute contents evenly in 60 to 75 linear feet of furrow. The dispenser bottle is calibrated in cubic centimeters (cc.'s) so that a fraction of the bottle can be used accurately. To avoid the fumes, work on the upwind side and pour fumigant well down in the furrow. Fill treated furrow promptly, rake level, and sprinkle with water to make a water seal. Repeat sprinkling as necessary to keep surface moist for 2 to 3 days.

DICHLOROPROPENE-DICHLOROPROPANE MIXTURES

Description	*Toxicity*	*Controls*	*Remarks*
Dark, slightly oily liquid. Volatile, non-inflammable. Fumes pungent, sweetish, slightly nauseating. Liquid burns skin if left in contact. Corrosive to metals in presence of water.	Somewhat less toxic to plants than chlorpicrin.	Nematodes Insects Fungi (slightly, if used with gas-tight cover).	Applied without dilution; does not require a water seal, but better nematode control with one.

To treat gardens and small areas. Open narrow furrows 6 inches deep and 12 inches apart. Distribute evenly 1 quart of dichloropropene mixture in 200 to 300 linear feet of row. An excellent dispenser can be made from a glass

Courtesy Section of Nematology, A.R.S., U.S.D.A.

Applying fumigant by pouring from fruit jar into furrow. After application furrow must be filled with soil immediately.

fruit jar with two nail holes punched in opposite sides of the metal cap. One hole dispenses the fumigant while the other allows air to enter the jar. The rate of discharge can be regulated either by the size of the nail holes or by the rate of walking. Calibrate the dispenser with water prior to using the fumigant. Fill treated furrows promptly and rake soil level to seal in the gas. Better nematode control is obtained if a water seal is used also.

An alternative method, less satisfactory for the gardener, requires a hand applicator or laborious and tedious application with a measuring spoon. To apply fumigant with a hand applicator, mark the area into 10-inch squares and inject approximately 1½ cubic centimeters of the fumigant at 10-inch intervals on the intersections of the first line, between intersections on the second line, on intersections on the third line, etc., as shown on page 56. Such staggered arrangement of injections provide the best distribution of the fumigant vapors. Step on injection holes immediately after applying chemical, rake level and apply water seal. A hand applicator may be purchased from many suppliers of soil fumigants.

To apply fumigant with a measuring spoon, mark area into 10-inch squares, then with a stick about ¾ inch in diameter, make holes about 6 inches deep at points indicated on page 56. Measure ¼ teaspoon of fumigant into each hole then seal by stepping on the hole. When an area is treated, rake level and apply water seal.

Applying soil fumigants with hand applicator that injects measured amounts at depth of about 6 inches.

Courtesy Section of Nematology, A.R.S., U.S.D.A.

ETHYLENE DIBROMIDE

Description	*Toxicity*	*Controls*	*Remarks*
Odorless, colorless liquid. Volatile, non-inflammable. Non-corrosive.	Much less toxic to plants than chlorpicrin.	Nematodes Insects.	Usually sold in solutions with suitable solvents. The solvents may present some fire hazard. Relatively cheap, commercial products are usually applied without further dilution. No water seal required. Can be obtained in capsule form for easy application.

To treat gardens and small areas. Since an ethylene dibromide formulation containing approximately 40% ethylene dibromide by weight will cover the same area as the dichloropropene mixtures, follow the directions for using dichloropropene mixture. If a formulation containing more or less ethylene dibromide is used, adjust the rate of application to correspond with the proportion of ethylene dibromide. In using capsule form, follow manufacturer's directions

FORMALDEHYDE

Description	*Toxicity*	*Controls*	*Remarks*
Colorless water solution of formaldehyde gas. Fumes pungent, irritating to eyes and mucous membranes.	Fumes toxic to plants but can be used safely in open air.	Fungi.	Can be readily obtained in small quantities; easy to apply. Requires dilution with large quantities of water leaving soil saturated. Do not use in closed area where plants are growing.

To treat gardens and small areas. Make a solution by adding 1 quart of commercial formalin to 49 quarts of water. With a sprinkling-can apply this dilute solution at the rate of 2 quarts per square foot of bed. Cover treated soil with canvas, burlap bags, or several thicknesses of newspaper. Sprinkle with water and keep cover moist for at least 2 to 3 days.

METHYL BROMIDE

Description	*Toxicity*	*Controls*	*Remarks*
Gas at ordinary temperatures. Very active.	Lethal to man and animals, but not particularly harmful to plants. Can be used safely within a foot or two of growing plants.	Nematodes Fungi Insects Weed Seeds (if used with gas-tight cover).	Often dissolved in cheap solvent to make safer and easier to handle. Use only with adequate ventilation. Can be used at temperatures down to 50°F.; soil can be planted about 5 days after treatment. Apply water seal as soon as possible after application. Gas-tight cover almost a necessity with this fumigant.

To treat gardens and small areas. Open furrows 6 inches deep at 12-inch intervals. For nematode control distribute evenly 1 quart of a 10% to 15% solution of methyl bromide in 100 linear feet of furrow. The glass jar dispenser is ideal for use with this fumigant. For fungus control distribute 1 quart in 12 to 15 linear feet of row. With either rate of application fill the furrows promptly and apply a water seal.

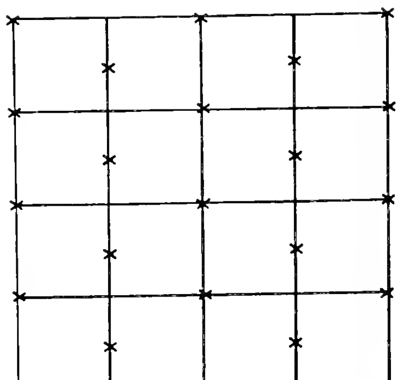
An alternative method is that suggested for dichloropropene mixtures. Mark area in 10-inch squares and punch holes to a depth of 6 inches at locations shown on next page. For nematode and insect control use 6 to 7 cc. per hole (approximately 1 teaspoonful). Use either a hand applicator or a measuring spoon. For fungus and weed seed control use about 45 cc. (approximately 3 tablespoonfuls) per hole. For the fungus control dosage, a jigger marked at the 1½ ounce level with a piece of adhesive or masking tape makes a convenient measure. Pour 1½ ounces in each hole and seal immediately by stepping on the hole. Work back and forth across the narrow axis of the bed. Stop after 10 minutes to sprinkle thoroughly the treated area, treat for another 10 minutes, and again stop to

Courtesy Section of Nematology, A.R.S., U.S.D.A.

Preparing seed bed for fumigation.

sprinkle the treated soil. Sprinkle the entire area again after treatment is finished and keep the surface moist for at least 2 days. If you use a gas-impervious cover, place cover over treated area after the first sprinkling.

The methyl bromide fumigants leave a bromide residue that is toxic to seeds of several kinds of plants. If you must use methyl bromide fumigated soil for seed flats, sow extra seed of the following sorts of plants to allow for reduced germination: *Dianthus, Salvia, Viola,* candytuft (*Iberis*), forget-me-not (*Myosotis*), *Ageratum,* and *Aster.* Except for the commercial carnation (*Dianthus caryophyllus*), rooted cuttings and older plants are not injured in any way when set into methyl bromide fumigated soil.



Author drawing

Scheme for applying fumigant. See text page 53.

Courtesy Section of Nematology, A.R.S., U.S.D.A.

Applying soil fumigant capsules. Holes are punched about 6 inches deep and one capsule dropped into each.

Other Uses for the Fumigants

The directions for treating gardens and small areas are applicable to seed beds, cold frames, and greenhouse beds and benches. Likewise, the same fumigants can be used effectively on soils in compost heaps, closed containers, and seed flats. Since fungi generally are the primary concern in such small lots of soil, and since such treatment may be applied in a closed area, we will discuss only the use of methyl bromide for compost heaps and closed containers.

Compost heaps to be fumigated should be 1 foot deep and rectangular in shape. Mark surface in 10-inch squares and punch holes 6 inches deep as indicated on the diagram. Apply 1½ ounces (3 tablespoonfuls) of methyl bromide per hole, smooth with a hand rake, sprinkle thoroughly, and seal fumes in with a gas-proof cover.

Soil in containers such as a large garbage pail or a 55-gallon metal drum can be treated conveniently with methyl bromide solution as follows: calculate the volume of container in cubic feet and multiply this number by 1⅔, which gives the fluid ounces required to treat the total volume of soil. Fumigant is applied at rate of 50 cubic centimeters (1⅔ fluid ounces or slightly more than 3 tablespoonfuls) per cubic foot. Measure total volume of fumigant required. For a smaller container such as a garbage pail, fill container approximately ⅓ full of soil, sprinkle on ⅓ of the

fumigant, add another 1/3 of soil, sprinkle on a second 1/3 of fumigant, finish filling container and sprinkle final 1/3 of fumigant over the surface. Cover surface with wet newspaper, or put on a tight gas-proof cover. If a 55-gallon drum is used, somewhat better results are obtained if approximately 1 cubic foot of soil is added, then the proportionate amount of fumigant sprinkled on, then a second cubic foot, etc. Use a tightly sealed gas-proof cover over such a large container. Open container after 12 to 24 hours and allow soil to air. Seed can be sown safely after 48 hours.

For fungus control in seed flats the formaldehyde drench is one of the best and easiest treatments to apply. Use prepared soil mixture, fill flats and apply about 1 quart of diluted formaldehyde solution per square foot of flat. Stack flats and cover with wet newspaper or burlap. Better yet, use a gas-proof cover. Remove cover after 3 days, air thoroughly until all odor is gone before planting.

How to Get the Best Results from Soil Fumigation

Unsatisfactory performance of a soil fumigant frequently stems from faulty application—inattention to one or more of the details that mean success or failure.

Before Fumigation

1. **Select a fumigant.** To choose a fumigant wisely, one should consider the particular pest involved, the delay required before replanting, and the location and size of the area to be treated. The proper fumigant to use will almost automatically be selected by the answers to these questions. A few fumigants will control nematodes, insects, fungi, bacteria, and also weed seeds. In considering the use of such a fumigant for an over-all control job it should be kept in mind that from 2 to 9 times more fumigant per unit area is required to control fungi, bacteria, and weed seeds than to control nematodes and insects only.

2. **Prepare the soil.** Since the fumigants penetrate only slightly into compacted soil, plow, spade, or till as deeply and thoroughly as possible—at least to 6 or 8 inches. Add peat, compost, or manure and work into the soil prior to fumigation. The prepared soil should be loose and free from clods, lumps, and unrotted plant material. A rotary tiller leaves the surface fluffy and powder-like allowing the fumigant to escape too rapidly. If a tiller is used, prepare the soil a few days in advance and allow it to settle.

3. **Moisture.** The soil fumigants work best in a fairly moist soil. A soil with the proper moisture should just hold its shape when formed in the hand and should crumble readily when dropped. If the soil is too dry, a 30% to 50% increase in dosage is required to achieve the same kill. If the soil is too wet, the fumigant fails to diffuse through it. Soil should be moist for 7 to 14 days prior to treatment to insure that weeds and various pests are in an active condition.

4. **Temperature.** The temperature of the soil at the 6-inch depth should be between 60° and 85°F. for best results. Below 60°F., except for methyl bromide, the fumigants kill slower and remain in the soil longer. Above 85°F. all fumigants may leave the soil too rapidly to be completely effective.

5. **Soil type.** Results of fumigation have been consistently better on light sandy soils. In either clay or soils high in organic matter the dosage rate may need to be increased somewhat.

Fumigation

Treat with the selected fumigant, apply it correctly at adequate dosage and seal promptly. Although the dichloropropene mixtures and ethylene dibromide are used without a water seal in commercial fumigation, a water seal definitely improves nematode control. For a good water seal, apply 1 to 2 pints of water per square foot which should wet the soil to a depth of 1 inch. Even better control of both nematodes and fungi

is obtained with gas-proof covers. These include polyethylene and vinyl plastics and glue-coated and asphalt-laminated papers.

After Fumigation

1. **Aeration.** Allow sufficient time for the fumes to leave the soil. Do not use the soil until *all* odor of the chemical is gone. Check for the presence of the fumigant by holding a handful of soil from the 4-to 6-inch depth near the nose and eyes and sniffing. Do not confuse the normal odor of sterilized soil with that of the fumigant. If wet, cool weather occurs after fumigation, allow additional time for aeration.

The average delay between treating and planting for the fumigants discussed is as follows: chlorpicrin and formaldehyde—10 to 14 days; dichloropropene mixture and ethylene dibromide—14 to 21 days; and methyl bromide—3 to 5 days.

2. **Recontamination.** Fumigated soil can be recontaminated by untreated, infested soil. By being aware how such recontamination occurs the gardener can avoid or at least delay it. Infested soil can be moved mechanically on hands, feet, tools, and plants, and also be transported by water. Thoroughly clean garden tools, flats, pots, etc., as well as the hands and shoes before moving from infested to clean soil. Trenches around seed or border beds prevent water from washing over them during heavy rains. Do not overlook the possibility of re-infestation originating from careless use of the watering hose. Carefully select planting stock of all kinds to avoid infested or infected material.

How to Avoid the Hazards Associated With Soil Fumigants

All the soil fumigants now available contain some volatile chemical that is more or less toxic to man and animals. None are dangerous to the operator when handled properly. Learn the proper technique for handling fumigants and adhere to it. Chlorpicrin, dichloropropene mixture, and formaldehyde give ample warning of their presence by the distinctive odors. Methyl bromide solutions and ethylene dibromide fumigants do not have such warning odors. If the fumigants are used outdoors in a slight breeze, indoors with adequate ventilation, or if the period of exposure is not long, they are no more dangerous than alcohol, gasoline, or electricity.

For any particular fumigant, follow the manufacturer's directions. The label will give information on any special precautions necessary.

Precautions To Be Taken With All Fumigants:

1. Avoid prolonged breathing of the fumes even if they are not obnoxious or irritating.
2. If liquid fumigants contact the skin, wash off promptly with soap and water and leave exposed area open to the air. Protect the eyes from spattering liquid. If it does get in eyes, pour plain water slowly into eye as a first aid measure until a doctor can be reached.
3. If liquid is spilled on clothing or shoes, remove the article at once. Do not wear these items until all the chemical is gone. The volatile ingredient when confined under an article of clothing may cause blistering or burns on the skin. Rubber gloves in general should not be worn. Rubber gloves and boots may not give satisfactory protection and may lull operator by a false sense of security.
4. Do not wear jewelry. Many fumigants are corrosive, especially in the presence of moisture.
5. Keep children away.
6. Store fumigants in tight containers away from sparks or open flames in a cool place. A ventilated building is best for storage.

When Not to Use Fumigants

When plant losses are not caused by organisms that fumigants will control, but occur for some other reason, the use of any soil fumigant is a waste of time and money. Soil fumigation will not correct poor drainage or lack of fertility. When the cause of plant loss is not definite or a diagnosis is not possible, make a trial application on a small scale before proceeding to treat the whole area.

For additional information on soil fumigation and the fumigants, see Cornell University Agricultural Experiment Station Bulletin 850 and United States Department of Agriculture Farmers' Bulletin No. 2048.

Future Possibilities

In the past the chemical fumigants have been useful only as a pre-planting treatment because of their toxicity to living plants. Although many of our food and ornamental plants may start life as clean, healthy plants in clean soil, unfortunately they may become infected later. Agriculture needs a material that can be used safely on living, growing plants that will either prevent the attack of pests or kill the pests after they have attacked the plant. This is a large order but ultimately research will find safe, easy-to-handle, effective chemicals that will control pests on established plants.

STERILIZING SOIL BY MEANS OF HEAT

Why sterilize soil? In outdoor gardens it is not often necessary, but many greenhouse growers prefer to use the same soil year after year rather than bring in new soil each season. Continually used greenhouse soil is almost certain to become infested with nematodes and other pests that must be destroyed if good plant growth is to be assured. Sterilization by heat is one means of achieving this.

The commonest, and in many ways the best, method of sterilizing soil by heat is to steam it. For quickest results with the least steam, the soil to be sterilized should be nearly dry. If moist, much more steam is required to raise its temperature to the sterilization level. Moreover, moist soil requires higher steam pressure for the steam to diffuse throughout the soil mass. When soil is dry and crumbly, steam will penetrate satisfactorily even though the pressure is low. Under such dry conditions a temperature of 180°F. must be maintained for 10 minutes for effective sterilization.

There are available commercial steam generating units for treating moderately large quantities of soil for greenhouse operations. However, these are not warranted for the average gardener. There are several methods of sterilizing small quantities of soil for use in a small greenhouse. For example, flats of soil can be treated by drenching thoroughly with boiling water. Or, several pints of soil can be steamed at a time by bringing ½ pint of water to a boil in a saucepan, then adding 5 or 6 pints of air-dried soil, covering tightly and boiling for 7 minutes. Allow to cool for another 7 minutes before removing cover.

Soil also can be pasteurized by electric heating. For electric pasteurization, the soil should be somewhat moist, and a temperature of only 150°F. is sufficient to kill practically all organisms in it.

Ordinary soil-heating cables used to warm cold-frames cannot be used for pasteurizing, as the high temperatures required cause their rapid deterioration.

For details concerning the construction and operation of steam and electric soil sterilizing units, the interested reader is referred to Cornell University Agricultural Experiment Station Bulletin 731, and a recent book by W. J. C. Lawrence of the John Innes Horticultural Institution titled SOIL STERILIZATION. It is published by the Macmillan Company, 60 Fifth Avenue, New York, priced at $3.50.

ANSWERS TO SOME COMMON SOIL QUESTIONS

What does moss growing on soil indicate?

Moss on soil is usually an indication of low fertility, too much shade, or poor drainage,—less commonly of an acid soil condition. It can be overcome by adding organic matter and fertilizers, then cultivating. (And in the few cases where acidity is the cause, by adding lime.)

When is soil ready to work in the spring?

Soil is ready to work when after compressing a small amount in the hand it forms a mass which can be readily crumbled. If the mass sticks together and will not fall apart, the soil is still too wet to work well.

Is it safe to use coal ashes as a fertilizer on soil?

Coal ashes are safe to use on soil provided the larger cinders have been removed by sifting, and the ashes have been leached for a short time to remove harmful gases. They have little or no value as a fertilizer, but do help to improve structure of a heavy soil.

What is the difference between quicklime and hydrated lime?

Freshly burned lime is called quicklime; lime that has been slaked in water is hydrated lime. Quicklime is caustic, will destroy humus in the soil, and should not be used.

How can soil be acidified?

Use finely ground sulfur (2 to 4 pounds per 1000 square feet) or aluminum sulfate. (See Plants & Gardens, Winter 1954-55, page 261.)

What is a green manure crop?

Green manure crops are crops to be plowed or spaded into the soil, such as winter rye, legumes, buckwheat, etc.

Why are legumes often used as green manure crops or in crop rotation series?

Legumes are members of the pea family and include clovers, alfalfa, vetch, soybeans and many other common plants.

As every gardener knows, nitrogen is one of the most important of plant mineral nutrients. The vast supply of nitrogen in the air is unavailable for most plants, so nitrogen must be supplied in various forms. Some bacteria, however, have the ability to take nitrogen from the air and "fix" it—that is, put it into a form which they and other plants can use. Some of these bacteria live free in the soil, but others in large numbers are harbored in nodules on the roots of various legumes. When such legumes are plowed under as green manures the nitrogen accumulated by the bacteria in the nodules is released into the soil, and is used by other plants.

What value has Vitamin B_1 as a stimulant in the growth of green plants?

Little or none. The original "evidence" of its value has long since been disproved.

Are sawdust, woodchips, and similar materials harmful to soil?

These materials are not harmful and can be used as summer mulches provided nitrogen fertilizer is added to the soil. They do not make the soil especially acid.

BEWARE OF THE LAWN (AND SOIL) RACKETEERS

Let every American home owner be warned . . .

George S. Avery, Jr.

TWO men drove up to a New Jersey suburban home in a truck loaded with rich-looking black soil.

"We've got some fine topsoil here," they told the young husband at the door. "Need some?"

It did look astonishingly good and the price was unusually low. The young man told the men to spread it. An hour later he paid the bill and gloated over his "bargain." The bubble didn't burst until nearly a month later.

The "topsoil," he learned, was actually a mixture of spent tea leaves from food factory dumps, mixed with charcoal to give it a rich, dark hue! Hundreds of other homeowners who bought huge quantities had complained to the county agricultural agent, who investigated and told them the truth.

An isolated incident in one section of the country? Hardly.

The fact is that fake topsoil peddlers, door-to-door sellers of dead and dying shrubs and purveyors of flowers, bulbs and seed for which extraordinary things are promised but never fulfilled, are having a nation-wide field day at the home owner's expense.

Millions Are Lost

And with the gardening season at hand, the swindle is on right now.

Government figures show that 57 per cent of all U.S. families now own their homes. Lawn cultivation and gardening have become virtually a national hobby. Realizing this, the gypsters are finding lush pickings from coast to coast.

Untold thousands are being gypped out of many millions of dollars annually by the smooth-talking chiselers. Increasing concern is being expressed by a number of groups in and out of the responsible horticulture industry.

The Garden Club of America, alarmed about the growing menace, devoted part of its annual forum recently to a frank discussion of the problem.

The Better Business Bureaus receive a large volume of complaints from fleeced customers. The New York group headlined a recent warning: "The rackets tha[t] bloom in the spring."

The American Association of Nurserymen was told flatly not long ago by Leland Jens, a member from Wisconsin: "The chiselers undermine confidence i[n] the entire industry."

Let me make one point clear. Th[e] vast majority of gardeners and nurserymen are honest, reliable businessmen wh[o] give value for money received. But th[e] spectacular rise of horticulture as a hobby and a means of beautifying the American home has attracted a horde of fly-by-nights who are finding it a good way o[f] turning a fast dollar. As Jens explains:

"By its nature, the nursery industry i[s] inviting to the scoundrel. Sales ar[e] bunched in one season of the year, thu[s] it is easy to operate a hit-and-run trade."

This fringe element pulls off a tricky bit of business such as this:

A year or two ago, salesmen wer[e] around suburban areas with an eye-bulging "new scientific development." I[t] was seed guaranteed to grow grass whic[h] would stop when it reached a height o[f] 3 inches. "You'll never have to mo[w]

your lawn again," homeowners were promised.

Intrigued customers bought the seed, the salesmen vanished — and the grass grew as high as any other.

Humus Peddlers

Itinerant peddlers of humus have a special bag of tricks all their own to bilk the customer.

One method: the truckman emphasizes that his price for the fertilizer is ridiculously low, points to a bushel basketful and says cryptically: "Only three cents." The home owner, impressed, tells him to spread the stuff over the lawn, goes inside and an hour later the truckman is at the door with the bill—which can and does range as high as $300. The humus is piled thick and deep all over the grounds, even stacked high behind the shrubbery.

"You needed much more than I estimated," the peddler explains. And he also points out to the stunned home owner that the material costs three cents per *pound*, not per basketful. "You must have misunderstood," he says blandly.

Another method: truckmen dump some of the fertilizer on a portion of your lawn, then ring your doorbell and tell you it's a free sample to show you how good it is. Few people want only a piece of their lawns fertilized, the rest barren. They order the remainder, frequently at above-average prices.

Action Being Taken

Action is now being taken on several fronts to blunt the sharp practices of the racketeers.

The Garden Club of America, which has alerted its members to the situation, is conducting a campaign of education so that buyers can spot the phonies.

The American Association of Nurserymen, together with the National Mail Order Nurserymen's Association, has adopted standards for advertisements.

The Nursery and Landscape Association of Dallas, Tex., is now asking the city's governing authorities to license all sellers of nursery products.

Courtesy Parade magazine

There is no substitute for good rich topsoil.

These are healthy indications, but you still need some rules for self-protection you can follow.

RULES TO AVOID SHARPIES

1. Don't buy indiscriminately.
2. Find out first exactly how much and what kind you need. You can get the answers from your agricultural experimental station—there is one in nearly every state (see page 20.)
3. Before buying anything, get an agreement in writing, no matter how simple. Have the seller state what he will furnish, what he will do.
4. Never pay cash in advance. Pay when the job is completed.

Armed with the specific answers, you can order a good deal more intelligently and your chances of being swindled will nose dive.

SOIL CONDITIONERS, SOIL STRUCTURE, AND PLANT GROWTH

How synthetic conditioners work and an evaluation of their use

W. P. Martin

IT is now generally accepted that, as Hilgard stated in 1906: "The physical condition of the soil must be determined before judging its fertility." Soils may be adequately supplied with plant nutrient elements and yet not allow a good plant growth unless they are loose and friable so that roots can develop normally and germinated seedlings easily break through the surface crust.

From the physical point of view the ideal soil is one in which the very small particles of silt and clay are bound together into larger aggregates or granules which do not readily fall apart when wet. A soil of this type does not crust as readily, allows relatively rapid infiltration of rain and irrigation water, and is not as subject to the ravages of erosion. Furthermore, it can be worked easily, is better aerated, drains quickly, and permits better root growth and greater activity of soil microbes.

Various factors are active in the formation of the water-stable soil granules. These include alternate wetting and drying, freezing and thawing, plant root action, and the presence of binding or cementing substances. In the best aggregated and most productive agricultural soils of the world a considerable percentage of the binding materials appear to be organic in nature and are formed as a result of the activities of microorganisms in the soil. The turning under of green manure crops and the incorporation of crop residues are accepted practices for the maintenance of soil tilth.

Organic Matter and Its Decomposition Products Influence Soil Granule Formation

Although some undecomposed organic materials may contain soil binding substances, most residues, if added to a soil in which the activity of the microbes is prevented, will have very little influence on aggregation (granule formation). Under natural conditions, however, such residues are immediately attacked by soil organisms causing decay. During the decomposition process (a) some of the microbes' waste products, (b) certain of the substances they manufacture, and (c) their own cells and thread-like bodies may all act to bind the soil particles together and thereby increase soil granulation.

Well composted materials and certain lignified wood by-products, also some peats which are not readily decomposed, have little effect on soil aggregation. In addition to these, active organic matter should be applied periodically, otherwise the number of stable aggregates originally produced will steadily decline.

Synthetic Soil Conditioners Improve Structure

The discovery that soil microorganisms, during the breakdown of organic debris, produce certain chemicals (known as polysaccharides) which help bring about the production of stable soil granules stimulated the search for synthetic compounds which would act in the same way but last longer in the soil.

Surface of untreated plot following spring disking.

A great many materials were turned up which had some aggregating activity. But some of them were required in very large amounts; others broke down rapidly in the soil; still others had waterproofing effects on the soil, increased the alkalinity too greatly, or poisoned the soil organisms. One group of chemicals did show desirable soil conditioning properties, however, and from this group three compounds have come to be most widely used as soil conditioners. The three chemicals are known as HPAN, VAMA, and IBMA.* These are simply abbreviations for the long chemical names of the compounds.

HPAN, VAMA, and IBMA are soluble in water, have good soil aggregating activity, and are not rapidly broken down by bacteria, so they remain active in the soil for a fairly long time. They have been commercially available since 1952 and at present can be obtained in powder, flake, or liquid form under a variety of trade names.

*Hydrolyzed polyacrylonitril, the half-calcium salt of vinylacetatemaleic acid copolymer, and the ammonium salt of isobutylenemaleic acid copolymer, respectively.

Surface of plot treated with soil conditioner following spring disking. Conditioner applied preceding year.

Author photos

Crusting and cracking of surface of untreated clay soil.

Factors Influencing Conditioner Effectiveness

As is often the case with new chemical products, exaggerated claims by over-enthusiastic advertisers led many users of soil conditioners to expect results which were not forthcoming. Despite some disillusionment, numerous studies have shown that the synthetic conditioners are effective in changing the structural properties of soils. Greater aggregation of particles, with increased porosity, permeability to water, and better workability have been found. The three commonly used conditioners are similar although in general IBMA is most active, weight for weight, followed by VAMA and then HPAN. Another type called CMC, which is also commercially available, is less effective than HPAN.

To be effective, the conditioners are best mixed with the soil at rates which vary from about 0.02% to 0.2%. The soil should contain enough moisture for good workability, but where conditioners in powder form are spread, the surface should be dry. "Gumming up" occurs if the soil is too wet and soil should be remixed after rain or irrigation fo greater effeetiveness. Conditioners ir liquid form are used on prepared seed-beds to prevent crusting or for the con-trol of erosion.

The effectiveness of the conditioners i also influenced by the nature of the soi in which they are used. In genera greater aggregation has been noted i fine-textured soils (clay soils) than i coarse-textured ones. They seem to b less active in highly acid soils. Ferti lizers may affect the degree of aggrega tion obtained, but in general in the fiel this effect is not important.

Durability or Persistence in Soils

Field and laboratory tests have show that the synthetic conditioners do resis breakdown by organisms in the soil an that the improvement in soil structur which they bring about persists mor than one year. There is a gradual de crease in amount of soil aggregatio especially in soils that are worked. I one test field in Ohio, VAMA was adde annually for 3 years to a clay loa soil. The last application was made i the spring of 1952 and the field st plowed easier in the spring of 1955.

Author photos

Same soil plot as shown at left after treatment with soil conditioner (.12 percent VAMA powder) followed by disking and subsequent cultivation.

Not a Substitute for Organic Matter

The synthetic soil conditioners are not a substitute for organic matter. Conditioners add no plant nutrients to the soil nor are they used by the soil organisms. They do improve the structure of the soil, and good structure and fertility often go hand in hand. Soils that are mellow and porous aerate better, which increases bacterial activity and speeds up the release of plant foods from the reserve in the soil. The development of roots is favored. This enables the plant to draw on a greater volume of soil for nutrients and water and often boosts yields. The incorporation and turnover of organic matter in soils continues to be an important factor in management.

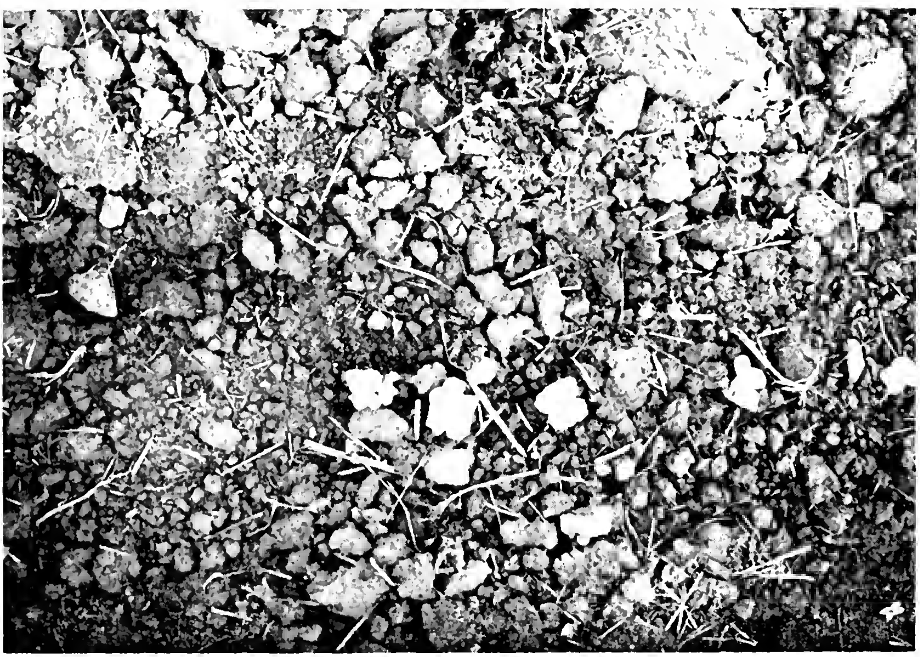
Reduction of Soil Crusting

A disadvantage of synthetic soil conditioners is their relatively high cost. One way of lowering rates of application to economical levels is to treat only the top half-inch of soil for the reduction of soil crusting. Spraying or sprinkling IBMA, HPAN, and CMC in solution (0.2% to 0.4% concentration) on the rows has successfully ameliorated crusting and improved plant emergence and stand. Mixing or disturbing the soil after such an application should be avoided or the effectiveness of the treatment may be lost. It has been observed that crust control treatments tend to dry the surface soil, often to a degree that is fatal to germinating seedlings of those grasses and legumes which have small seeds. In both spring and fall plantings, turf establishment was facilitated by an organic mulch regardless of soil conditioner treatment.

Aid in Transplanting

In transplanting seedlings of such plants as tomatoes, petunias, and tobacco, pouring a dilute solution of conditioner into the transplant hole (either alone or along with starter fertilizer) is sometimes helpful. The conditioner stabilizes that part of the soil first penetrated by new roots, and prevents crusting against the tender seedlings.

Emergence of plants was almost entirely prevented by a crust condition which developed in bands of untreated soil above. Surface application of soil conditioner liquid (below) prevented crusting and aided emergence of seedling plants.



Summary of Results Obtained with Conditioners

Extensive studies in many parts of the world have shown that when applied properly and in the correct concentrations synthetic conditioners do improve the physical structure of the soil. This is especially true of heavy, fine-textured (clayey) soils. From this a number of secondary results follow:

1. Water infiltrates soil more readily, leading to
   - Less erosion
   - More extensive root development of plants
   - Better water supply to zones of root growth
   - Better drainage of wet soils, especially in spring
2. Soils are better aerated, leading to
   - More bacterial activity which makes more available plant food
   - Better root growth
3. Plants emerge from soil more easily
4. Soil is more easily worked

The net effects on crops are variable. Sometimes the yields are increased, othertimes not. Root crops are often improved and are cleaner when dug. As a result of better spring drainage, improved seedling stand of some crops has been obtained on wet ground. On treated soils plants often not only get off to a more rapid start, but mature more quickly. Early ripening generally results in a more favorable market situation for high value crops and would substantially change the picture so far as the economy of use of the expensive synthetic conditioners is concerned.

The widespread use of synthetic conditioners in agriculture that was early anticipated has not materialized—due largely, it is believed, to high prices and difficulty of satisfactory application. Despite these drawbacks, they can be a valuable aid to gardeners and farmers in situations where heavy (clay) soils present serious problems.

To test whether synthetic conditioner might improve your soil, add 4 or 5 drops of water to small handful of dry soil to which you are considering applying conditioner. Mix soil and water thoroughly.

If firm soil "cigarette" can be formed, clay soil is indicated and structure of soil will be greatly improved by chemical conditioner.

If soil "cigarette" when formed will not hold taut shape, chemical conditioner may offer enough structural improvement to warrant application.

If soil remains granular and will take no shape, no advantage will be gained from adding chemical soil conditioner.

Photos caurtesy Mansanta Chemical Company

THE TINIEST CRYSTALS IN SOILS PERFORM BIG JOBS

Many gardeners think of clay as a nuisance but it plays a vital role in the soil

Tsuneo Tamura

EVERY gardener has at one time or another encountered problems of puddled, infertile, acid, or poorly aerated soil. These problems are intimately associated with the kind, amount, and condition of clay in soil.

Clay Mineral Make-up

Both rocks and soils contain minerals. In fact, the larger sand grains of soils are the same kind of minerals which composed the consolidated parent rocks from which they came. But the breaking up of rock into smaller and smaller bits is only part of the story of soil formation. Nature adds rain, air, acids, and living things to the earth's surface and these all act to decompose the original minerals of the rock. The elements liberated from the minerals in this manner recombine to form new minerals which are more stable than were the originals. These new minerals occur in exceedingly small particles (generally less than 1/10,000 of an inch in diameter) and form the clay portion of the soil.

The nature of the clay minerals was difficult to discover. Since the particles are too small to be seen with the microscope, they did not yield up their secrets until such powerful research tools as the X-ray and the electron microscope were turned upon them. We now know that the clay particles have the form of flat, plate-like crystals. Chemically they are made up mostly of silica and alumina.

In one basic type of structure the clay particle is a layer of silica with another layer of alumina. This unit may be visualized as a slice of bread with butter spread on one side. The butter layer corresponds to the alumina layer and the bread to the silica layer. This basic structure is the pattern of the clay mineral called kaolin.

If we add another piece of bread (silica layer) to the buttered side of the slice to make a sandwich, we have a unit comparable to the mineral talc, the mineral often used in face powders. The kaolin and talc structures are the basic framework of clay minerals.

Our analogy goes even further. One slice of buttered bread will stick to another slice. That is, the butter on one side will adhere to and make a bond with another slice of bread. But sandwiches are less inclined to stick to one another when stacked. Likewise in clays it is difficult to spread apart stacked units of kaolin due to the formation of special chemical bonds; talc opens up much more easily.

To make our sandwiches more nearly comparable to clay mineral structure, we cut holes in the bread, for the silica layers have "empty" spaces distributed throughout.

Just as we can have wheat or rye bread, and butter, jam, or jelly in sandwiches, so too can the clays have different elements in the so-called silica and alumina layers. For example, the element silicon in the silica layer may be replaced by aluminum. Aluminum is the basic element in the alumina layer. Changes in either of the layers alter the nature of the mineral, and consequently of the clays made up by them.

Cation Exchange Explained

When chemical salts (including those which are used as fertilizers) dissolve, their molecules split into smaller bits called ions. These ions are electrically charged, some positively, some negatively. Positive ones, of which calcium and potassium ions are examples, are called cations. The negative ones are anions. The surfaces of the clay particles are also charged, most of them being negative. Because of the attraction between unlike charges, the cations are attracted to the clay particles and held to them. Later other cations may exchange places with the cations already on the clay particles, pushing them back into solution again. This changing places by ions held on the surfaces of clay particles is called cation exchange.

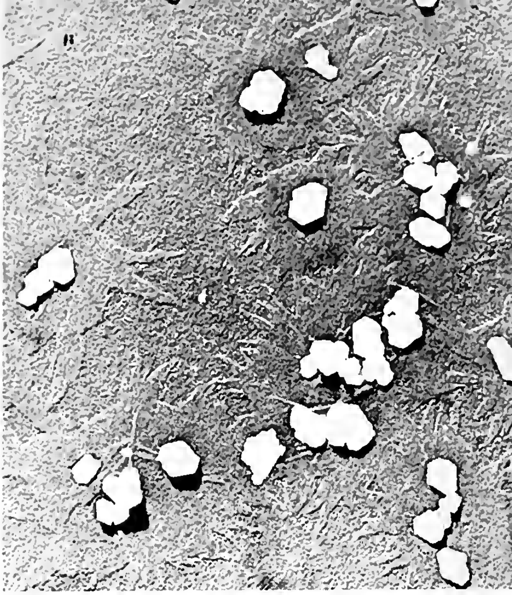
Suppose a chemical fertilizer such as potassium nitrate is added to soil. It dissolves in the soil water and splits into potassium cations and nitrate anions. Both of these ions can be quickly washed away by any water moving through the soil, but the potassium cations are attracted to the clay particles and held by them. At some later time when other kinds of cations come along, perhaps hydrogen cations which could have come from acids excreted by plant roots, they may change places with the bound potassium cations. These are then free in the soil and can be picked up by plant roots. In this way the process of cation exchange enables clays to act as storehouses for many valuable plant nutrients.

Light, sandy soils with little clay must have a limited capacity to store many of the elements needed by plants. On such soils, therefore, it is better to give frequent small applications of fertilizer than to give large doses less often.

It should be kept in mind that humus in the soil has the same capacity that clay has for storing nutrient elements.

Clays and Soil Structure

In fine-textured soils the physical properties of the clays are important in determining air and water relationships.



Author photo

Electron micrograph of crystalline particles of clay magnified 16,000 times.

The most favorable conditions are obtained when the clays are aggregated. This involves the grouping of the primary particles of sands, silts, and clays into larger secondary units, called aggregates or granules. Many factors play a part in aggregation (see page 64).

Excessive amounts of clay lead to very bad structure, but in proper amounts clay can act as a conditioner, binding soil particles into granules. The binding and cementing qualities of clay minerals in holding the aggregates together are related to their flat, platelike structure. Quartz in particles as small as those of clays does not act as a binder because the quartz particles are not flat.

Clays in which the particles have picked up a coating of calcium cations are much more effective in aggregation than clays with sodium cations. Clayey soils near the ocean oftentimes have an excess of sodium on the clay. The application of gypsum (hydrated calcium sulfate) will improve the structure of such soils.

When one considers the many uses of clays in the making of bricks, pottery, china, tile, etc., together with their important functions in the soil, one realizes that, indeed, these "tiniest crystals in soils" perform big jobs.

THE SOIL

Your life depends upon it

E. J. Rubins

MAN depends upon green plants for much of his food, fiber, fuel, and shelter. The medium for the growth of these plants is the soil. Tillage of the soil not only forms an essential part of our civilization, but it also provides a means of recreation and relaxation for those whose livelihood is obtained in other ways.

The soil consists of rock and mineral fragments, organic materials, air, and water. But is is far more than a mere mixture of these, just as a tapestry is not a haphazard collection of colored threads nor an automobile a random agglomeration of nuts, bolts, sheet metal, and other miscellany. The soil's components may be organized into many different patterns with properties that vary tremendously. A practical result of this variation is that some soils produce abundant crops with a seeming minimum of effort on the part of the gardener while others give only a grudging response under the best of conditions.

Soils Differ in Nature

Why is this so? There are many reasons. One of the most far-reaching is that the action of the climate and of the vegetation associated with the climate exert a profound effect upon the production of soil (pp. 74-75). The kinds of soil that develop in the tropical jungle differ greatly from those of the hardwood forest in the humid temperate region. These soils in turn are quite unlike those of the arid deserts or of the sub-humid grasslands. The physical, chemical, and biological conditions that
prevail in each of these regions are quit
different. These differences find expres
sion in such obvious ways as the colo
and thickness of the various soil layers
and in many other ways that are not a
all obvious but are important from th
standpoint of soil fertility. For instance
it is well known that soils of humid re
gions in their natural state are less fertil
than soils of drier areas. In the former
the leaching (dissolving) action of rai
over the years has washed out some o
the soluble chemical nutrients needed fo
plant growth. Replacement of these b
the use of lime, manure, and fertilize
is required for the satisfactory produc
tion of most crops in humid regions.

Local Variation

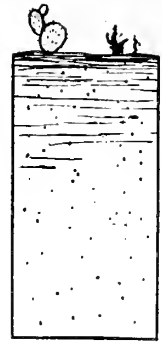
Not only are there broad difference
among soils from different parts of th
world resulting from differences in cli
mate and native vegetation, but differ
ences are found among neighboring soil
in any given locality. This variation ma
be attributed to a number of causes suc
as differences in under-drainage, in slop
or in the kind or rock that contribute
the mineral portion of the soil. In som
cases the mineral matter did not originat
from the rock immediately beneath th
present site, but may have been brough
in and deposited by some geological forc
such as the action of glaciers or glaci
streams in the past, or by flooding stream
in more recent times. In such cases, th
agency that transported the soil materia
whether wind, water, or ice, helped de
termine the character of the soil tha
eventually resulted.

Buhle

Local conditions influence the soil profile. Soil at top of slope on the right is a well-drained upland soil, another type of well-drained soil develops on the valley sides, and at the bottom near the stream is a poorly drained meadow soil.

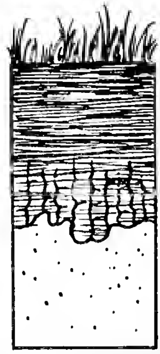
Texture

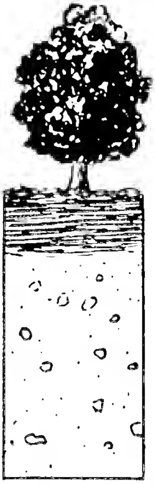
In the strict sense of the term, the gardener deals with soil material rather than soil because the mixing action of tillage destroys the natural sequence of layers developed over the centuries by the soil-forming processes. But whether or not the soil has been disturbed by man, it is useful to obtain some idea of the relative fineness or coarseness of its mineral portion. This property is known as texture. Coarse-textured soils are well-aerated and easy to manage, but their ability to hold moisture is low and their water supply must be replenished frequently for good crop growth. Fine-textured soils hold moisture well but are difficult to manage.



A desert soil with scant vegetation and little organi matter. Such soils are ofte very fertile when irrigated

A black-earth of the sub humid grasslands. The deep surface layer is predominant ly mineral but is dark be cause soil particles are coat ed with humus derived from decomposition of many fi brous grass roots. Such soils are not acid and are rich in plant nutrients.

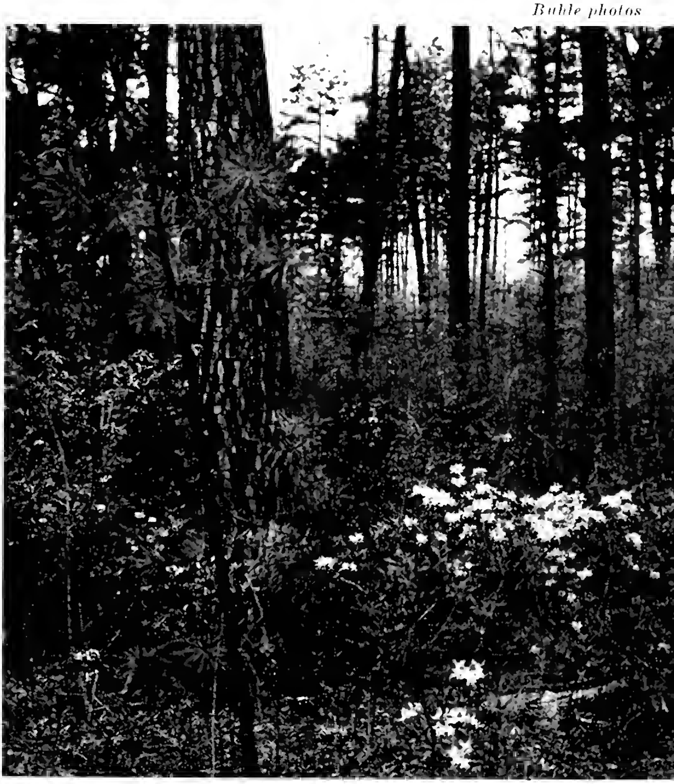


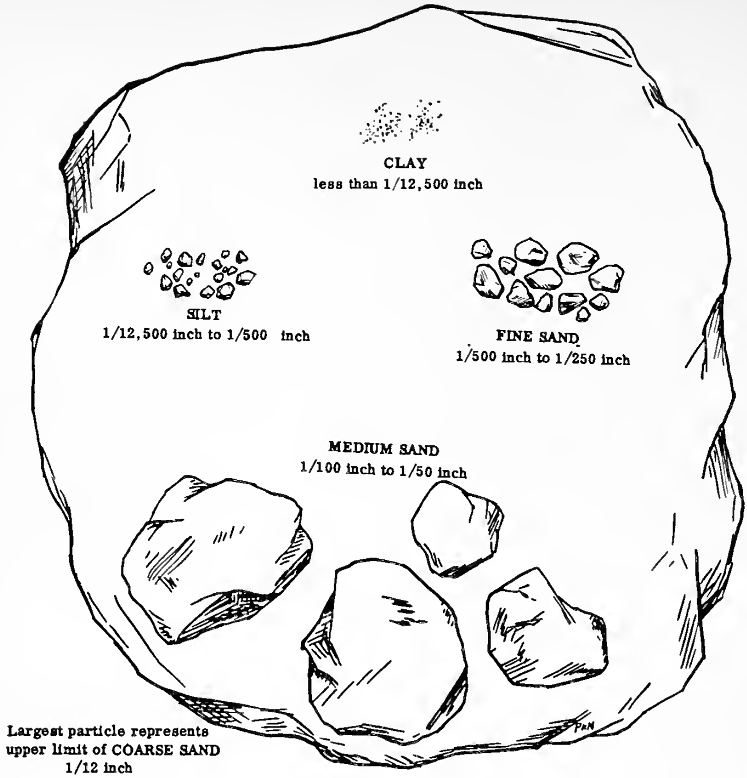


Deciduous forest soil of humid temperate region. Layer of leaf litter is followed by layer of mineral soil mixed with humus by action of earthworms and other soil animals. These soils are moderately acid and not too fertile under natural conditions.

Coniferous forest soil of humid cool temperature region. Layer of pine needles is folowed by one of raw humus. Underneath is layer of almost pure silica sand followed by brownish or yellowish layer containing some organic matter and mineral particles leached down from layers above. Soil very acid and infertile.

Buhle photos





Particles of mineral matter in soil. This diagram shows them magnified about 50 times.

Mineral Matter in the Soil

For the purpose of deciding the textural name of the soil, the mineral particles are separated into three groups, sand, silt, and clay, solely on the basis of size. Individual clay particles are sub-microscopic; silt particles can be seen with a microscope; while individual sand grains can be seen with the unaided eye. Particles larger than the largest sand grains (about 1/12 inch in diameter) are ignored in determining soil texture. The relationships between some of the textural names are shown opposite. Note that "sands" are not necessarily all sand nor are "clays" necessarily all clay. Loams represent a desirable balance between the extremes of sand silt, and clay. Soil texture can be determined very accurately in the laboratory but it can also be estimated in the field by an experienced person. Sand feels gritty; silt feels floury; clay is harsh when dry, and sticky and plastic when wet. With a little practice the relative amounts can be estimated by rubbing a pinch of soil between the thumb and forefinger.

Soil Structure

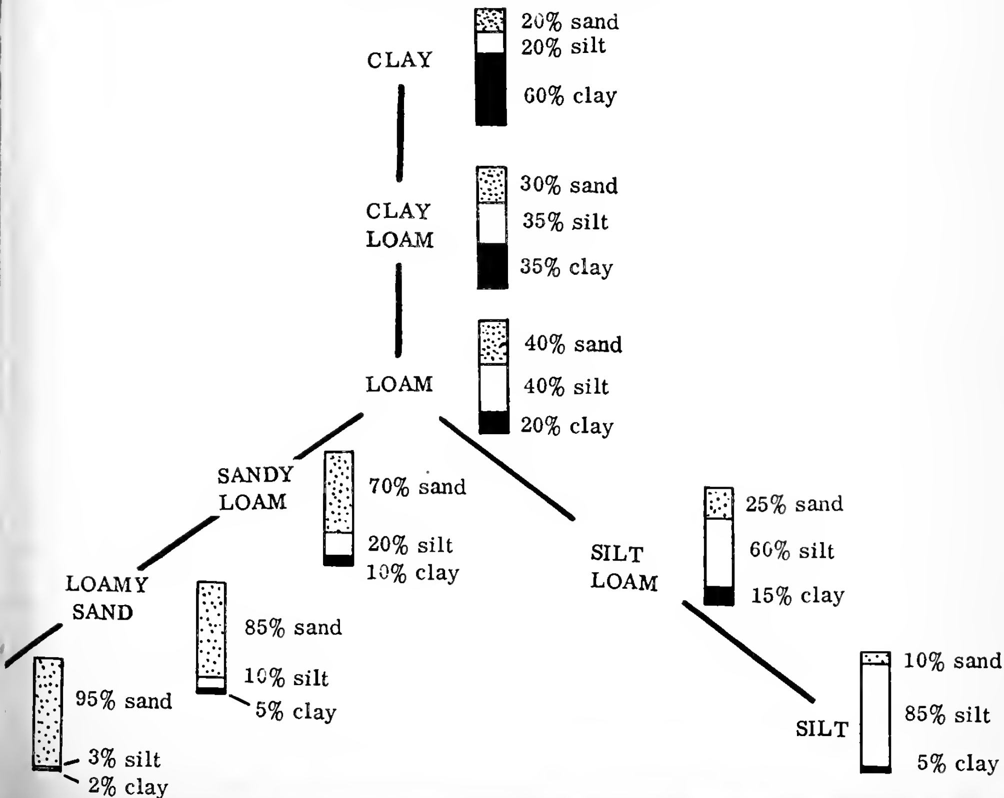
It was mentioned earlier that soils are more than a mere mixture of their various components. The property termed soil structure provides an important illustration of this. (See page 78.) Structure refers to the clumping together of the sand, silt, and clay particles to form

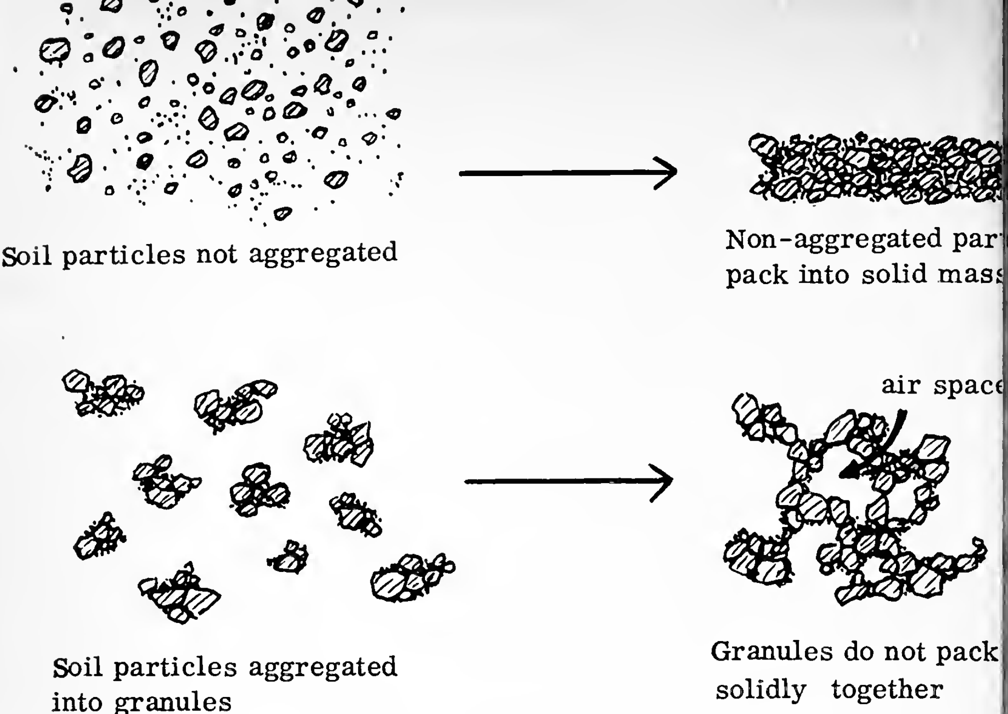
granules or aggregates. There are many types of soil structure but the one commonly found in the surface layers of soils of the humid temperate regions is called crumb or granular. Surface soils in their native state or soils that have been in sod for a few years show this kind of structure. The large pore spaces between the granules make for rapid penetration and drainage of heavy rains, thus reducing surface runoff and lessening the danger of erosion. Granular soils are also well-aerated yet the ability of the soil to retain part of the water for crop use is not hampered because the granules themselves are porous and can soak up and hold water in their tiny internal pores. Under continuous cultivation the granular condition of the original soil deteriorates. In fine-textured soils this is particularly serious because the increased compaction results in poorer drainage, poorer aeration, and impaired ability to handle heavy rains. The latter is associated with increased erosion. Retiring the land to sod for two or three years will restore the granular condition. The action of the living grass roots with their attendant soil microorganisms and dead organic tissue play an important but little-understood role in creating granular structure.

Active Materials of the Soil

The soil is far from being an inert mass. Not only must the many complex activities of the multitude of living organisms that make their home in the soil be considered, but some of the nonliving components are found to be centers of physical and chemical activity. **Clay** is one of these active substances; **humus** is the other. Clay is manufactured from other minerals as a part of the soil-forming process. The kind of clay (and to some extent the amount of clay) in the soil depends upon the climate during the centuries of soil development. In contrast, sand and silt represent minerals that have resisted the

Relationship between kinds of soil, typed according to structure. Percentages of sand, silt and clay given for each kind merely suggest representative analyses for typical members of each group.





How soil structure affects packing of soil.

weathering process and have been inherited from the parent rock chemically unchanged.

Humus is organic in nature. It is the end-product of the activities of a whole sequence of humble soil organisms that use plant and animal remains as sources of food. Humus itself is rather resistant to further change. It can absorb a great deal of moisture and it has a dark color. In woodland soils the layer immediately below the leaf litter is rich in humus. Humus imparts its dark color to soil layers otherwise predominantly mineral in nature.

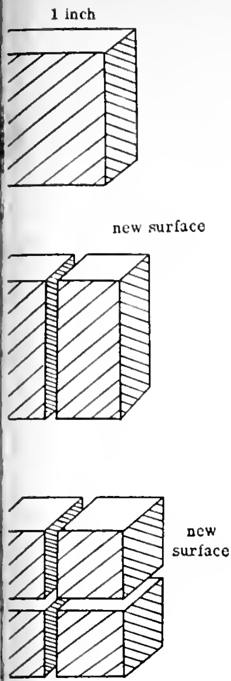
Clay and Humus—Storehouses for Nutrients

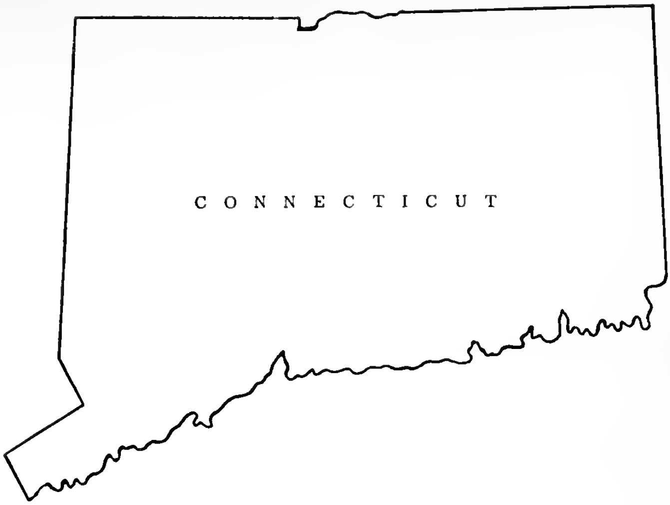
Pound for pound both clay and humus possess tremendous surface areas, the first because the particles are so small, the latter because of its spongy nature. The total surface area possessed by the individual particles of the top 6 inches or so of an acre of soil amounts to several thousand square miles. Clay and organic matter contribute the major portion of this. This surface is able to hold onto many chemical elements dissolved in the soil water bathing it. Many of these elements are plant nutrients and when so held are readily accessible to plant roots. Thus clay and humus serve as nutrient storehouses.

In humid regions the leaching action of rain gradually removes the surface-held nutrients, particularly calcium and magnesium. The soil then becomes acid. Soils of humid regions in their native state are almost invariably acid and infertile. Lime is applied to overcome the acidity, and to restore the calcium and magnesium. Although some crops require (or can tolerate) acid soils, most grow better when the soil is well limed.

Some nutrient elements are not held on the surfaces of soil particles; these tend to leach readily. Phosphate is held in the soil by a special mechanism.

While clay and humus are similar in certain respects, they are unlike in others. Soils high in clay content are notoriously difficult to handle. If tilled when wet compression occurs with the formation of compact lumps or clods, which become very hard upon subsequent drying. These clods should not be confused with the





Dividing solid material into fine particles enormously increases its surface area. Particles in an average garden soil are so finely divided that their total surface area of particles in top 6 inches of soil on one acre may roughly equal area of the state of Connecticut, 4,899 square miles.

orous granules or crumbs developed aturally under sod. In contrast to clay, umus by itself has desirable physical roperties and it will, when incorporated nto the soil, improve the physical conition of a mineral soil layer.

The soil is a product of many interting forces that have operated upon over a great span of years and connue to operate at the present time. It a very complex medium with many inrlocking parts. When man does varis things to the soil in growing his rops, whole chains of reactions and ounter-reactions are set off with somemes favorable and sometimes unfavorble results.

Organisms in the Soil

Not only do man's activities affect the active, inanimate parts of the soil, clay d humus, but they also affect the myrils of soil microorganisms that comprise e equally reactive living part of the il. Most of these are general-purpose ecay organisms that perform the valuble service of converting fresh organic atter into humus, releasing in the proces chemical nutrients in simple inorganic orms that are ready to re-enter plant roots. But sometimes these organisms enter into direct competition with the crop. For instance, if plant tissues high in carbohydrate and low in protein are plowed under shortly before a crop is planted, the decay organisms will appropriate soil nitrogen for their own development and the crop may suffer.

Other soil microorganisms perform special and unique services. Perhaps the most important of these is the conversion of atmospheric nitrogen into chemically combined forms that can be used by plants. Some of the organisms that can do this job are associated with the nodules on the roots of legumes while other kinds are free-living in the soil.

In dealing with the soil it is important to remember that it is an active, dynamic medium. If used wisely it will be a source of pleasure and profit. At the same time it should be remembered that it would be almost impossible to find two soils that are exactly alike because of the tremendous number of environmental possibilities that have played a part in shaping each one. What constitutes wise use under one set of conditions might not hold for another.

Gardener's Guide to Sources of Fertilizers AND Soil Fumigants

As an aid to gardeners wishing to obtain products related to the content of this issue, the Brooklyn Botanic Garden has made available space to selected firms whose notices appear on these pages. When writing them, please make reference to PLANTS AND GARDENS.

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ROOKLYN BOTANIC GARDEN RECORD

PLANTS & GARDENS

LAWNS

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SUMMER
1956

NEW SERIES
. 12 No. 2

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PLANTS & GARDENS

VOL. 12 Summer, 1956 No. 2

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Editorial

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NOTICE OF CHANGE OF ADDRESS AND ALL OTHER CORRESPONDENCE SHOULD BE ADDRESSED TO: BROOKLYN BOTANIC GARDEN, BROOKLYN 25, N. Y.

Eight Points for Fine Lawns

1. Use of grasses suited to climate and local weather.
2. Sufficient light, or use of shade-tolerant grasses.
3. An adequate supply of moisture, i.e., proper watering, when needed.
4. Sound maintenance practices, i.e., proper cutting, weed control, etc.
5. Protection from injury, including mechanical, insects, and diseases.
6. Good soil structure, 50% solids, 25% air, 25% moisture.
7. Favorable soil reaction (pH).
8. A fertile soil with ample amounts of plant food elements, i.e., adequate seasonal fertilization.

Noer and Wilson

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES
BROOKLYN BOTANIC GARDEN
1000 WASHINGTON AVENUE
BROOKLYN 25, NEW YORK
TELEPHONE: MAIN 2-4433

Summer 1956

This special Handbook on lawns and grasses is a guidebook for those who feel that a beautiful lawn gives a lift to the spirit, and is an asset to any garden.

The most beautiful lawns, like golf greens, are of one kind of grass. They have uniformity of color and texture, and for general perfection they have no rivals. But there are hazards. I recall with pleasure a beautiful Velvet Bent lawn of my own, built several years ago. It had the "come on" of a golf green, and grew well in sun and shade. But during the hot August of its second summer, to my disappointment, it began to turn brown. By the time I discovered the infestation of chinch bug (see page 121 for control), it was too late. The lawn was dead, except in the shade of a Scots pine where the chinch bugs lost their appetite. In this lightly shaded spot there is still a cherished remnant of Velvet Bent. I wish I might have had this Handbook for a guide ten years ago!

The great advantage of sowing a grass mixture (page 110) is that among the grasses which make it up, there will almost surely be one that is better-suited to the environment than others. One or more are certain to succeed. Given the right grass seed mixture, proper preparation for planting (page 139) and reasonable care, a successful lawn is assured.

Now a brief look at the grasses of the world that have nothing to do with lawns. All of them bear flowers at one season or another, and are therefore flowering plants. There are some six thousand different kinds. They belong in the same great class with palms, iris, lilies, orchids—and even onions. On the whole, their flowers are not spectacular, but most people are familiar with tassels and ears of corn. These are groups of male and female flowers.

Grass flowers are wind pollinated, and the pollen of some kinds, such as sweet vernal grass, is an important cause of spring hay fever.

Grasses grow in almost every climate, from the tropics to the arctic, from prairie to desert, and a few species even grow in water. They probably cover (or once covered) more square miles of the earth's surface than any other single family of plants. American grasslands of the Great Plains region are an impressive example.

The Eastern Parkway gate to the Botanic Garden has grasses as its theme, for three cereal grasses supply the primary foods for mankind. These alone have cradled the three great civilizations: Rice is still the basic food plant of the oriental peoples; Europeans had wheat; and the American Indian probably could not have survived without Indian corn.

But this Handbook is about lawn grasses, the elite few of the world's thousands that are adapted to making living green carpets for "Everyman's garden" in the western world.

To the Editor and his authors, our congratulations. Good lawn making!

Sincerely yours,

George S. Avery, Jr.

Director

Scher

Perforated plastic hose distributes water gently over large area.

WATERING LAWNS

How to make the most effective use of water, how to judge the need for water, and how to prepare for unavoidable drought periods

Fred V. Grau

As a nation, we are running out of good pure water. Only recently have we begun to develop a national consciousness of the seriousness of the situation. Water is essential for all of the life processes of grass and other living things. Life depends upon water in the proper quantities, in the right place, and at the right time. Each of us may expect to be asked to make significant contributions to water conservation in the near future. Many of us already are painfully aware of the consequences when unexpected limitations in water use are imposed upon us during periods of drought. One of th first of such restrictions is the ban o watering lawns. Lawns that have bee conditioned in advance for just suc emergencies will be far superior to tho which have been managed for continuin generous supplies of water. Briefly, the it would seem to be good business to de velop the kind of lawn which will b satisfactory with the minimum of supple mental irrigation and which will have th best chance of survival if and when wate is denied or restricted.

All Lawns Are Watered

Acceptance of this basic premise is essential to the practical understanding of the use of water on lawns. Grasses are very efficient in extracting water from the soil for their life processes. Grass roots may draw water from a few inches to as much as 6 or 8 feet down. Grass roots will not grow in soils that are lacking in moisture. Lawns receive water from natural rainfall and, when this is not sufficient to sustain growth or appearances, from supplemental irrigation. The quantity of water supplied by rainfall, as well as the distribution of it, is highly variable. For this reason it has not been possible to develop standard patterns for irrigating lawns. We need to take into consideration the type of soil on which the lawn is growing, the kind of grass present, the quality or degree of excellence demanded, the expected frequency of rain, temperature, wind, and humidity, all of which affect water losses from the grass and from the soil, as well as depth of rooting and height of cut. We have only begun to understand how each factor affects water use but, in spite of the seemingly complicated array of limitations, it is possible to make several simple statements which will help the lawn owner to do a better job of watering lawns.

Objectives of Watering

Our objectives are to maintain in the soil sufficient moisture for satisfactory growth and performance of the grass, periodically to replenish that which has been lost through drainage, plant use, and evaporation, and completely to recharge the soil to the full depth of the effective rooting of the grass. Irrigation to supplement rainfall should be only *as needed*. A basic concept is to space irrigation periods as far apart as possible. Another is to water in depth. Frequent light sprinkling or showers which wet only a shallow depth tend to induce shallow rooting. Shallow-rooted grass is poorly adapted to withstand traffic or periods of drought.

Watering Is Affected by the Kind of Soil

Soils are classed roughly as *sands, loams,* and *clays.* Sandy soils hold less water than clays and water drains through faster, so that watering needs to be done more often. Loam soils are intermediate between sands and clays. A 12-inch depth of loam soil may hold the equivalent of about 1½ inches of available water. Sands would hold about half that amount and clays about twice as much.

Water is more effective when the soil is open and porous so that it soaks in instead of running off. Most soils become crusted or compacted at the surface under the influence of traffic and watering. When this occurs there is less absorption and more runoff, resulting in waste of water, excessive costs, and actual damage to root systems and to the turf. Even though sandy soils tend to absorb water more easily than heavy soils, they too, become compact so that they shed water like a roof. The answer to this seems to be periodic aeration or cultivation with mechanical equipment to permit the easy infiltration of water.

A basic concept of watering, then, is to "apply water only as fast as the soil can absorb it." It is difficult to overemphasize this because it is so very important. If sprinklers tend to apply water too rapidly it will be necessary to move them more often, bringing them back to a partially-watered area as soon as the first watering has penetrated, repeating this until the soil is wet to the full depth.

Good drainage promotes the development of deep root systems that can utilize moisture effectively. Poor drainage makes it very difficult to grow good grass. The basic reason for this is that grass roots are living and need air (oxygen) just as you and I. Without the oxygen in the soil grass roots are unable to absorb either water or nutrients. This is why grass turns yellow and dies when there is too much water in the soil over too long a period. Furthermore, soils are teeming with microorganisms which help to make fertilizer materals available to the grass and to de-

Bluegrass makes beautiful turf, is intermediate in drought tolerance. During warm weathe its growth slows down even if abundant water is given.

velop humus which has a beneficial effect in holding moisture in the soil. These microorganisms also need air. Good drainage allows excess water to drain through the soil carrying harmful waste products with it and drawing fresh air into the soil.

Light sandy soils that drain very rapidly tend to develop deep extensive root systems because of the excellent aeration but at the same time they lose dissolved nutrients more rapidly in the drainage water. This situation demands heavier, more frequent fertilizing which is beneficial to maximum root development. Heavy roots add organic matter to the soil which aids in holding water.

Grasses Differ in Water Requirements

The usual method of classifying lawn grasses into cool-season (bents, bluegrasses, fescues) and warm-season (Bermudas, zoysias, centipede, St. Augustine, bahia, carpet) is not helpful when we consider water requirements. Based on water needs, we can make three groups of turf grasses.

1. Very drought tolerant: Bermud grass, centipede grass, bahia, zoysia, buf falo grass, grama grass, crested whea grass, fescues.

2. Moisture loving (little or no drough tolerance): rough bluegrass, annual blu grass, creeping bent, carpet grass, and S Augustine grass.

3. Intermediate in drought toleranc Kentucky bluegrass, some strains of ben grass—especially Colonial bent.

The deep-rooted grasses, like Bermud can effectively utilize the moisture in larg volumes of soil and thus continue to gro for long periods between waterings. Son grasses escape drought by curling the leaves which reduces water loss throug leaf openings; zoysias and fescues do thi Underground storage organs (roots ar rhizomes) store food and moisture wi which they renew growth following period of drought which causes death all topgrowth. Bermuda, buffalo, and blu grass have such storage organs.

Some grasses slow down in growth du ing high temperatures (bluegrass, ben fescues, buffalo) and refuse to "pushed" even when water is suppli

Author photos

Centipede grass, much used in the deeper South, is highly drought resistant.

in abundance. Mis-applied water in these cases simply encourages unwanted growth of several weeds, crabgrass in particular. Bermuda and zoysia, on the contrary, respond to water and fertilizer during these periods. These are just a few of the more important considerations in choosing the grass for the lawn.

Well-Fed Grass Resists Drought Better

Recent experimental work has proven that plants which are adequately supplied with nutrients actually require less water for growth and development. We have known for a long time that well-fed lawns suffer less from drought and they can go longer periods between waterings and still look better than lawns that are starved. There is little question but that well-fed lawns have fewer weed problems and that they can withstand wear and tear much better. It is safe to say that the majority of lawns suffer more from *starvation* than from lack of water. Yet we see on every hand, wherever we go, misguided attempts to make water substitute for fertilizer. The sensible approach to better lawns, then, first is to supply all the required nutrients in adequate quantities so that a constant supply always is available to the grass. Fertilizer programs for lawn grasses are dealt with elsewhere in this handbook (p. 91). It is sufficient, here, to say that each grass must be fed according to its requirements as to season and the degree of excellence demanded. The various agricultural experiment stations provide excellent information as to proper fertilization of the various grasses adapted in each state.

As an example, I should like to cite instances where I have seen well-fed Bermuda grass turf remain attractive and hold good color after 90 to 100 days between waterings. Starved turf went completely brown in less than half the time; both were in daily temperatures of 100° F. Well-fed MERION bluegrass has resisted these high temperatures and remained in good condition for 35 to 40 days between waterings. Many other examples could be given but these should serve to emphasize the very great importance of feeding grass to resist drought—"a well-fed lawn requires little watering."

A sprinkler such a this distributes wate reasonably uniforml over a large area. (se p. 166)

McFarland

Methods of Applying Water to Lawns

Most lawns that receive supplemental irrigation are watered with sprinklers. These may be of the pop-up type that is buried in the turf, sprinklers that attach to recessed valves, or moveable sprinklers that are attached to a hose. A few lawns that are level are watered by flooding and some are sub-irrigated. The variations in types of equipment offered to the lawn owner defy description or an accurate count. Regardless of the claims fc various devices, one basic principle pr vails—water should be applied uniforml and only as fast as the soil can absorb i Intervals between waterings should be a long as possible and water should l applied only when the grass shows tl need for it. Because of soil variation some areas of the lawn may need wate ing more often than others. If, becau of compaction or crusting or tight so it is not possible completely to "refill tl soil reservoir" in one watering, it must repeated at intervals until the soil is w to the full depth of the root system. Wh runoff occurs it may be an indication th the soil needs loosening, aerating, or cul vating. (Repeated cultivating of a hea soil will encourage root growth in t soil cavities and this will aid in wat absorption.)

Aerating tool helps break surface compaction by making small holes—to a depth of 4 or 5 inches. More rapid movement of air and water into soil can result.

Mesecro

Holes and cores left by aerating tool. T idea behind lawn aeration is reasonable, b not all lawn experts agree on its usefulne.

Aut

Installing plastic hose for permanent sprinkling system. Only "pop-up" sprinkling heads are feasible for such an installation; other types present a hazard to maintenance tools.

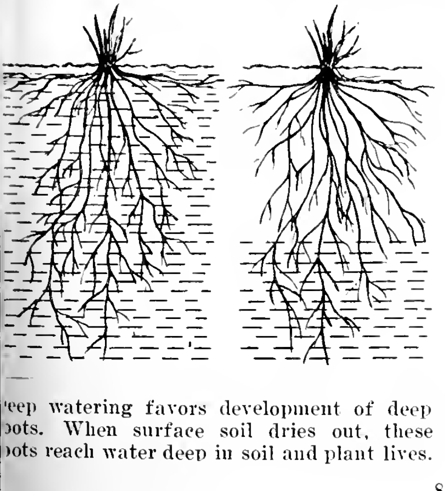
Schery

Perhaps the very worst practice in ;atering lawns is to hand sprinkle the rass every day or so (the curse of too ittle too often). This promotes a shallow oot system and encourages weeds and iseases.

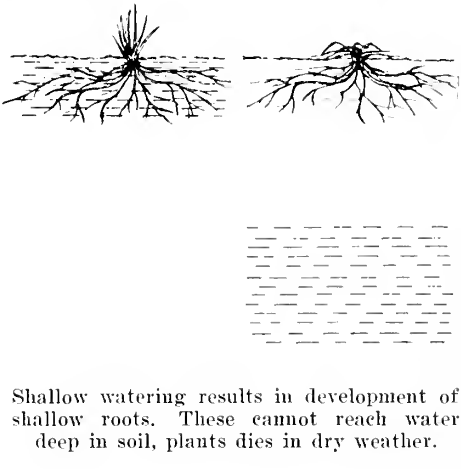
There has been a great deal of discusion about the best time of the day to ;ater a lawn. Some say that watering ;hen the sun is shining will "burn" the rass. Actually, the best time to water is when the grass needs it. The time of day makes little difference. There is less evaporation when water is applied in the evening but grass that is wet all night runs the great risk of becoming diseased.

Watering a lawn is largely a matter of convenience so that someone is there to move the sprinkler, or to shut it off, when it is necessary. The human element of judgment is very important. A simple mechanical device known as a "soil probe"

'or new lawns in particular, shallow watering favors growth of shallow root systems. In ry weather shallow rooted plants cannot reach water deeper down. Many newly established lawns fail for this reason.



'eep watering favors development of deep ɔots. When surface soil dries out, these ɔots reach water deep in soil and plant lives.



Shallow watering results in development of shallow roots. These cannot reach water deep in soil, plants dies in dry weather.

Autho

Dense shade spells trouble from tree roots which rob the grass of moisture as well a plant food.

is important also so that the depth of penetration of water may be determined. Also extremely important is the ability of the individual to recognize the appearance of grass that is in need of water. The best time to apply water is just before the grass starts to wilt. Each grass develops a characteristic appearance when this stage is reached and only close observation can determine this.

Watering Schedule Must be Based on Good Judgment

By now it should be apparent to even the most casual reader that it simply is not possible to develop any kind of a watering schedule that will apply to everyone's lawn, nor to all portions of any one lawn, nor to any one portion of one lawn during all seasons. One needs to know his soil, his grass and its nutrient requirements, among other things. *It should be obvious to most of us that watering of lawns with supplemental irrigation adds to our problems. We get more weeds and increase the incidence of disease, it costs money, we have to mow more often, fertilize more often, we increase crusting and compaction, and most serious of all, by municipal decree we may be denied the water the grass needs just at the time it needs it most.*

All of this should strengthen our re solve 1) to select the best lawn grass fo a given situation, one that requires mini mum irrigation, 2) to cultivate our soil to achieve maximum absorption of rain fall and irrigation water, and 3) to ferti lize adequately and thus reduce the nee for irrigation.

Watering an open lawn with no trees i an entirely different proposition than wa tering one which is interspersed with tree of assorted kinds and sizes. Trees compl cate the problem by virtue of the shad they cast, the need for different grasse and the heavy tree use of water. So t maintain the best possible lawn throug all kinds of weather:

1. Make sure the soil is in condition receive the water, whether it be rainfa or irrigation, and aerify as needed.
2. Make sure the grass is adequate fertilized.
3. Refrain from irrigating until it really needed.
4. Soak thoroughly to effective ro depth, but move sprinklers or shut the off if the soil cannot absorb as fast as t water is applied. Turn the water on aga when the soil is able to absorb it, and r peat until it is soaked to desired depth.
5. Do not water again until it is rea needed.

LAWNS NEED FERTILIZER

What, when, and how much

H. B. Musser

A working knowledge of how to handle fertilizers is essential in both the establishment and maintenance of good lawns. To better understand what is involved let's examine some basic facts of soil fertility and plant growth.

Plants are living organisms. They need food for growth and development. They must get most of this from the soil. Roots do the job of collecting this food material. Because roots have no mouths, but absorb food materials through their cell walls, the materials must be dissolved in the soil water. Within rather wide limits, they will take up anything and everything that is in solution. This is the first working fact that the user of fertilizers must recognize. How much and how fast plants use fertilizer depends upon the rate at which it goes into solution in the soil water so that roots can get it.

The second basic fact is concerned with something that we fully recognize in looking out for our own nutrition. Most of us like to eat pretty regularly. We realize that if we do not, we soon run short of the proteins, carbohydrates, and fats needed to keep us in good condition, to say nothing of essential vitamins and minerals. These same principles apply to the use of fertilizers. The necessary plant food materials become exhausted. Some disappear quickly and some last longer, depending upon their character and how fast the roots use them. Yet time and again we try to make a lawn get along with one scant application of fertilizer a year, without the slightest idea of whether it is enough or how long it is going to last.

The third item of background information that will help in formulating a sound fertilizer program consists in a working knowledge of what fertilizers are. What do we actually get when we buy a bag of fertilizer, and how can we compare its value with a bag of another kind?

What's in the Fertilizer Bag?

There is a quite long list of materials considered essential for normal plant growth. Some of these, such as oxygen, come from the air. That is why it is so necessary to keep the soil in good condition. If air cannot move through it freely the grass roots will not get sufficient oxygen to keep them functioning properly. Of course oxygen is not a plant food, but it *is* essential to grass plants—just as it is to everything else that is alive.

Most of the necessary plant food materials come from the soil. Many of these, such as iron, manganese, sulfur, and boron, are used in very small amounts by grass and usually are present in most soils in sufficient quantities to meet its requirements. These are called "trace elements." It is necessary to include them in the regular fertilizer program only when there is reasonable evidence that a particular soil may not have them. This is likely only for very sandy soils or for soils such as peats and mucks with a high organic matter content.

The plant food materials that most commonly are in short supply in soils and which the grass needs in relatively large quantities are nitrogen, phosphate,

Musser

Nitrogen is the key growth-producing element in fertilizers. Dark strips in this turf received nitrogen fertilizer in fall; photo taken the following April.

and potash. Nitrogen is important because it is the key growth-producing material and because soils do not retain it for very long. Soils normally contain very limited quantities of phosphate and often it is in an insoluble form which grass roots cannot absorb easily. Total potash supply is often high but frequently it is held so tightly by the soil that there is not enough going into solution at any one time to meet the needs of the grass. The practical fertilizer program, therefore, hinges upon applications of these three materials.

Fertilizer manufacturers understand this and produce a wide variety of fertilizers that are mixtures containing varying quantities of each of these nutrients. The mixtures are identified by the actual percentage of each plant food material

If fertilizer is spread by hand great care should be taken to avoid such uneven distribution as here shown. Use of spreader is preferable (see page 139).

McFarland

present. The order in which the percentage of each material is given has been standardized. For example, a 10-6-4 fertilizer means that 100 pounds of it will contain 10 pounds of nitrogen, 6 pounds of phosphate, and 4 pounds of potash. No matter what company manufactures it, if it is a 10-6-4 it will always contain these same total amounts of plant food per 100 pounds of the fertilizer. This gives us an excellent starting point for comparing the cost of different fertilizers. A 10-6-4 should cost more, and actually is worth more than a 5-6-4 because it contains twice as much nitrogen as the latter.

Complications Develop

The problem of comparing fertilizer values would be quite simple if relative cost were the only consideration. Unfortunately, fertilizer manufacturers may use a wide variety of materials to supply the actual quantities of plant food materials present in the fertilizers. This is not so important in the case of phosphate and potash as it is for nitrogen. Only a few products supply the two former economically, and so the same materials are used in most mixed fertilizers to supply these nutrients.

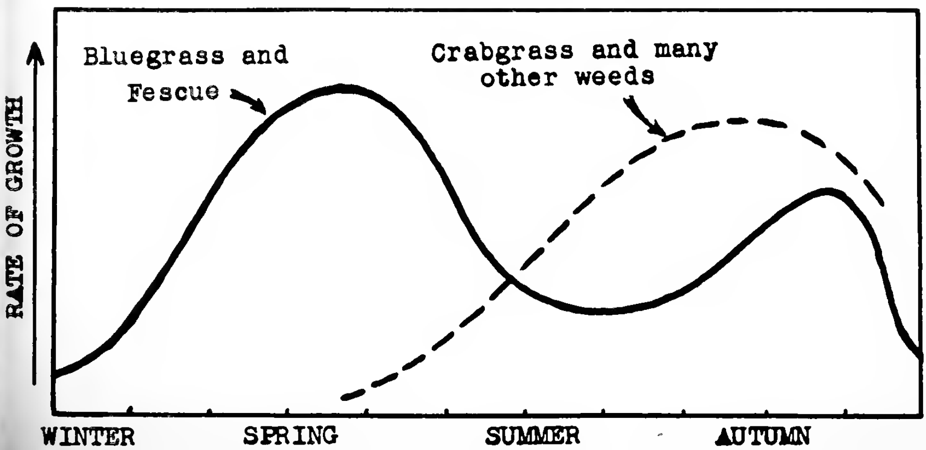
Nitrogen is a different story. Manufacturers use many different kinds of materials as sources of nitrogen in mixed fertilizers. Some of these, such as ammonium sulfate and urea, are highly soluble in water and release the nitrogen they contain within a very short time after they are applied. Others, such as the natural organics like processed sewage sludge, various seed meals, and the new urea-formaldehyde compounds (see PLANTS & GARDENS, Spring 1956, page 10), give up their nitrogen much more slowly. They must be broken down by soil microbes before their nitrogen becomes soluble and this process takes time. Sometimes it may be much more desirable to apply a fertilizer that becomes effective slowly than to use a quick-acting form. And so the kind of nitrogen which a fertilizer contains may become an important factor in determining its value. Also, it is a guide as to how much should be used at any one time.

The answers to the practical questions of what to buy, when to apply it, and how much to use will differ, depending upon whether it is for the establishment of a new lawn or maintenance of an old one.

Fertilizing a New Lawn

The first necessary step in building a new lawn is to thoroughly work the soil so that it is loose and well aerated to at least a 6-inch depth. Liberal quantities of phosphate and potash should be applied during this operation and worked down into the soil as deeply as possible. It is much easier to get uniform distribution of these materials through the entire tilled layer at this time than if they are applied on the surface. A good fertilizer mixture for this purpose is an 0-20-10. This will contain no nitrogen, 20% phosphate, and 10% potash. The actual amount

Seasonal growth cycles of grasses and weeds. In summer desirable bluegrasses and fescues grow little, even if well fed. Applying fertilizer at this time simply encourages crabgrass and weeds, which grow well at this season.



that should be applied can best be determined by a soil test. If it is impracticable to obtain such a test, an application of 50 to 60 pounds per 1000 square feet of lawn area would be considered reasonable. Any lime needed to correct acidity can be put on at the same time and worked in along with the fertilizer. It is not necessary to apply nitrogen at this time. Much of it would be lost before the roots of the young seedling grass could get it.

We are now ready for the final grading and leveling operation preliminary to seeding. Just before this is done a fertilizer containing a high percentage of nitrogen should be used. In the final grading operation it will be worked into the surface to a depth of 1 or 2 inches. This places it in the immediate root zone of the young seedlings where the nutrients which the fertilizer carries are easily accessible. Fertilizers such as a 10-6-4 or ones carrying even higher percentages of nitrogen are excellent. If all of the nitrogen which they carry is in an immediately soluble form the amount applied should be limited to a quantity that will supply a maximum of 1 pound of actual nitrogen per 1000 square feet. Thus if a 10-6-4 or a 10-10-10 analysis were used the total quantity of either should be 10 pounds. (Since these each contain 10% nitrogen, 10 pounds of either provides the 1 pound of nitrogen wanted.) When a fertilizer is used that contains 50% or more of its nitrogen in a slowly available form the rate of application can be increased to 2 or 3 pounds of actual nitrogen per 1000 square feet.

Fertilizing an Old Lawn

Lawn fertilization can be a straightforward relatively simple procedure or an extremely frustrating hit or miss proposition, depending upon how much effort an individual is willing to put on learning something about his soil requirements and the materials he is using. A soil test will provide an excellent basis for determining how much phosphate and potash should be used annually. If a soil is found to be low in these materials a fertilizer should be used once a year that will supply at least 4 or 5 pounds of each per 1000 square feet. Where soils contain medium to high amounts the rates can be cut back to 1 or 2 pounds. The only complication of such a program is in selecting a mixed fertilizer that carries the right percentages of phosphate and potash in relation to the nitrogen it contains.

To illustrate, let's assume that the content of phosphate and potash in a particular soil is good and it is necessary to add only 1 or 2 pounds of each per year. In such a case a 5-10-10 fertilizer applied once a year at a rate of 20 pounds per 1000 square feet would meet the demands of the turf for these materials. On the other hand it would supply only 1 pound of nitrogen (5% of 20 pounds). If the fertilizer were applied in the early fall this 1 pound of nitrogen normally would be sufficient to meet turf requirements for the remainder of the season. But certainly it could not be expected to have much effect the following spring.

The rest of the fertilizer program, therefore, is concerned with providing an adequate quantity of nitrogen for the spring and summer. This can be done in two ways. Small quantities of a fertilizer carrying only nitrogen in a quickly available form can be used periodically during the season. Materials such as ammonium sulfate, nitrate of soda, urea, or ammonium nitrate can be used. Applications should be limited to not more than ½ pound of nitrogen at one time and should be repeated at approximately monthly intervals until hot weather arrives. No nitrogen should be used during the midsummer period.

Since each of these materials carries a different percentage of nitrogen the rate of application will depend upon which one is used. For example, ammonium sulfate has 20% nitrogen. It would be necessary to use 2½ pounds of this fertilizer per 1000 square feet to get the ½ pound of nitrogen required per application.

There are two serious objections to this

Noer

Permanent lawn damage (death of grass) may result from applying soluble fertilizer in hot weather without thorough watering immediately after.

method of getting the needed amounts of nitrogen during the spring and early summer season. The first is the most important. All fertilizers that carry nitrogen in immediately soluble form will burn grass unless thoroughly watered in promptly after application.

The second objection is the time and trouble of making repeated applications and of watering following each. It not only interferes with vacations but it can seriously upset golfing dates and even just sitting on the front porch.

Fortunately, there is a much simpler alternative. There are a number of materials that carry nitrogen in slowly available form. One application of any of these made in the spring, at a rate to supply 3 or 4 pounds of nitrogen per 1000 square feet, is sufficient to carry the turf through the entire season. The processed sewage sludges and tankages, seed meals, and the new urea-formaldehyde formulations belong to this class of materials. Not the least advantage in using them is that they can be applied in very liberal quantities without danger of burning the grass, even though no water is used. Since each carries a different percentage of nitrogen a simple calculation again is necessary to determine the quantity of material needed.

It does not seem that there is anything very complicated or difficult in the foregoing suggestions. They are based on well understood and generally accepted principles of soil fertility and fertilizer performance. In essence, they recognize that plants need constant, adequate, and available supplies of certain nutrient materials. They outline the use of these essential materials at rates that experience and many experiments by trained research workers have shown to be reasonable. Above all, they should demonstrate the necessity for very careful investigation of "miracle" materials that undertake to supply all our fertilizer needs with an application of a few pounds at an outrageous price.

THE ROLE OF SOIL TESTS IN LAWN FERTILIZATION

How they can be used as a tool in planning a fertilizer program

O. J. Noer and C. G. Wilson

SOIL testing to determine fertilizer needs has become extremely popular. Many county agricultural agents have facilities for making quick soil tests and there are inexpensive soil test kits on the market for layman use. The ones for testing soil alkalinity or acidity (soil reaction) are satisfactory provided instructions are followed. Some of the kits for other quick soil tests are also satisfactory, but the best way is to send samples to a responsible laboratory manned by trained personnel, where reagents are kept fresh at all times and turf grass agronomists interpret the results. The agricultural experiment stations in most states have soil-testing laboratories (see PLANTS & GARDENS, Spring 1956, pp. 20-23) and many of the fertilizer manufacturers have a soil-testing service for their customers. Charges for these services are small—in some cases services are free.

When lawn grass grows poorly, it is often due to lack of plant food. A fertile soil is essential. However, other factors affect growth, and must be favorable before fertilizer will produce the results expected of it. (See frontispiece.)

Acidity vs. Alkalinity—Lime in Lawn Maintenance

The acidity or alkalinity of the soil affects the accumulation of organic matter, the animal and plant life of the soil, granulation or soil tilth, and the availability of plant food elements.

Soil reaction is expressed in terms of pH. The scale is from 0 to 14, with 7 as the dividing point or neutrality. Figures below 7 represent increasing acidity, ones above, increasing alkalinity. Each figure differs by a multiple of 10, so pH 6 is ten times, pH 5 one hundred times, and pH 4 one thousand times more acid than the neutral pH 7.

Few soils fall outside the range of pH 4.0 to pH 8.5 (see chart); most are within the narrower limit of 5.0 to 7.5. Most lawn grasses grow best in the range of pH 6 to 7.5. Soils which are more than moderately acid, that is, below pH 5.7, definitely need lime and its use is justified without regard to any other factor. Kentucky bluegrass is a classic example of a lime-loving turf plant. It will not tolerate marked acidity and is at its best when reaction is above pH 6.0. Ryegrass and Bermuda grass also grow best at or near neutrality. The fescues and bentgrasses grow over a wide range of reaction and will tolerate more acidity.

The rate of applying lime is determined by the kind of soil. Less lime is needed on a sandy soil than on a loam or clay to produce the same change in pH. This factor and the requirements of different kinds of grass are taken into account in the following table.

The figures given are for fine to medium ground limestone, and should be increased 25 to 50 per cent for coarser ma-

Amounts of Ground Limestone to Apply to Lawns

(Rates given are pounds per 1000 square feet)

Soil pH before applying limestone	Degree of acidity	Pounds necessary to make soil most suitable for grasses indicated			
		Bluegrass Bermuda Ryegrass		Fescue Bentgrasses	
		Sandy loams	Loams and clays	Sandy loams	Loams and clays
7	Neutral	0	0	0	0
6.3 to 7.0	Very slight	0	0	0	0
5.8 to 6.2	Slight	25	35	0	0
5.3 to 5.7	Medium	50	75	25	35
4.8 to 5.2	Strong	75	100	50	75
4.0 to 4.7	Very strong	100	150	75	100

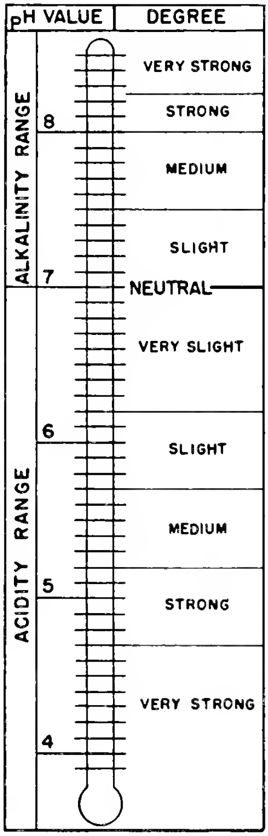
terial. Rates should be reduced by 25 to 30 per cent for hydrated lime, because 74 pounds of hydrated lime are equivalent in neutralizing value to 100 pounds of pure ground limestone.

When soils are sufficiently acid to need lime, it is desirable to have tests made to determine the quantities of available calcium and magnesium. Ordinary limestone supplies calcium, so if calcium is very low, heavier liming is justified than would otherwise seem necessary. In addition to its effect upon acidity, a reasonable amount of calcium is desirable because of beneficial effects upon soil granulation, and to prevent fluctuations in reaction.

Some acid soils are so deficient in magnesium that plant growth is checked as a consequence. Then a dolomitic limestone, which contains magnesium as well as calcium, should be applied. One containing not less than 20 to 30 per cent magnesium should be used.

Soil Structure Depends Upon Soil Reaction

Marked acidity has an adverse effect upon the physical condition of loams and heavier soils, resulting in a plated type of soil structure impervious to water. Such soils are apt to produce a shallow-rooted turf unable to withstand adverse conditions.



Author diagram

Acidity or alkalinity of soils as shown on the pH scale, the "thermometer" used to indicate acidity or alkalinity.

Author photo

Most grasses grow best in a nearly neutral soil. Dense strip of turf through center of plot above shows where lime was used as a boundary marker 20 years previously, neutralizing a strip of otherwise somewhat acid soil.

Soil Reaction and Availability of Food Elements

Soil reaction also affects the availability of essential plant food elements. Phosphorus is less available in acid soil, whereas strong acidity increases the solubility of trace elements such as copper, manganese, iron, etc. Poisoning by copper, which is extremely toxic to plants, can result in strongly acid soil. On the other hand, too much lime makes all the essential trace elements insoluble and hence unavailable to plants. Lime-induced iron chlorosis (lack of chlorophyll—see PLANTS & GARDENS, Winter 1954, p. 258) is a classic example of this in semi-arid regions where soil reaction is naturally alkaline.

Soil Nutrient Testing

Grass roots can absorb only nutrients in solution. The amount of dissolved nutrients in soil water is small, seldom more than enough for a day or two. The solution must be replenished continually, especially when plant growth is rapid. A fertile soil maintains a satisfactory nutrient level in the soil solution at all times. Productive soils are never static; they are dynamic and undergo constant change during the growing season as a result of the solvent action of the carbonic acid secreted by roots, and the activity of soil microorganisms.

Every soil contains three classes of plant food elements, based on their relative availability. The soluble nutrients in the soil solution are immediately available. Another portion is insoluble but in forms which become readily soluble when needed by the growing plant. The third class is soluble with difficulty but may become available—years hence. It is similar to a person's finances. The pocket change is enough for a day or two. It corresponds to the immediately available plant food. There is the checking account in the bank which can be drawn upon when the pocket change is exhausted. This is similar to the insoluble but readily available plant food. Defaulted bonds are of no value in the foreseeable future, but may regain their value eventually. They correspond to the hard-to-dissolve plant food.

Turf behavior is the best gauge for judging need for nitrogen. The most obvious signs of nitrogen deficiency are poor color, thin grass, slow rate of growth, and the presence of clover and weeds. Soil tests for nitrogen are not reliable for turf grass areas. Existing methods measure the quantity of soluble nitrate nitrogen in the soil. Grass roots absorb this type of nitrogen almost as fast as it is formed by the soil microorganisms, so a soil test usually shows a deficiency not borne out by the growth of the grass.

Soil tests are designed to determine need for lime, and to estimate the amount

That this lawn needs fertilizer is indicated by enhanced growth of grass where spot applications were made to fertilize tree.

Clover taking over a thin lawn is one of the most obvious signs of need for nitrogen.
Author Photos

Musser

Soil in three plots at left has has favorable pH for bluegrass; soil in two plots at right is so acid that grass grows poorly. EXPLANATION: High acidity makes phosphate in soil less available to turf. Important to check soil pH. If too acid for kind of grass grown, add lime!

of water-soluble and immediately available phosphorus, potassium, calcium, and magnesium in the soil. Testing for only four out of fifteen essential elements may seem inefficient to the reader. Yet years of experience have shown that where soil reaction and these four elements are kept in proper balance, lawn fertilization becomes primarily a matter of supplying the right amount of nitrogen at the proper time.

For simplicity and convenience, most laboratories report results as very high, high, medium, low, or very low. Although these terms appeal to the layman, they are misleading as ordinarily applied. Fertilizer levels should be higher where clippings are removed and active growth is maintained by frequent and generous watering. Leaving the clippings results in an appreciable return of major nutrients to the soil after decomposition takes place. Nitrogen is a notable exception.

Sampling

Many of the unreliable results given by soil tests are due to poor sampling. Depth of sampling is very important. Two samples taken at the same spot but to different depths will contain different amounts of available phosphorus and potash. The deeper sample contains less.

To obtain consistent results and to show and follow trends, it is necessary to take samples to *exactly the same depth at all times.* The amounts of phosphorus and potash decrease sharply with depth on grassy areas because the soil is not disturbed after turf coverage is obtained. Failure to appreciate this fact has been responsible for misleading results even with the better soil testing methods. This is the reason for specifying a standard 2-inch depth of sampling.

In taking samples, it is important to have them truly representative. All plugs should be uniform in diameter and taken to an exact depth of 2 inches. Small, inexpensive soil sampling probes are available through most golf and lawn supply houses. The probe also is a handy tool to use in examining the soil for moisture needs, and to check on effective rooting depth. A very good one can be made from a discarded steel golf shaft, as illustrated.

Variations in soil, topography, and turf determine the number of composite samples to collect. On level areas of uniform soil, four to six composite samples suffice. Each should consist of four to six cores of uniform diameter and exactly 2 inches long. They should be taken from widely separated spots on the lawn. When sampling a localized area of poor turf, collect another sample from a nearby spot of good grass. Include information about drainage, kind of grass, maintenance, watering, and fertilizer practices.

Each sample should be air dried before placing in a clean, new container for shipment. Label the outside of each sample plainly with a soft lead pencil, giving pertinent information.

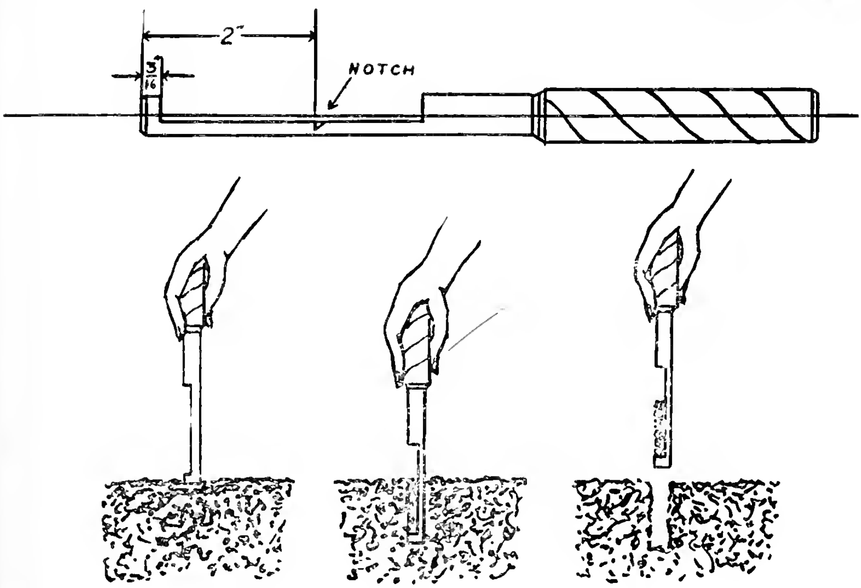
Yearly testing is seldom necessary. A test every three to four years is usually satisfactory.

The important points to remember if a soil test is to provide worthwhile information are:

1. Representative grass areas must be sampled at exactly the same 2-inch depth.
2. Laboratory testing must be done by a method reliable for grassy areas.
3. The results are best interpreted by scientists familiar with the plant food requirements of turf grass.

A simple and efficient home-made soil sampling tool made from steel golf shaft. The slot is cut to just past center line, to make removal of soil cores easier. When taking sample, tool is inserted in soil exactly to notch, then withdrawn with core.

Redrawn from authors



Grau

Dandelion is one of the commonest and most persistent lawn weeds because of its air-borne seeds that favor rapid spread, and its deep taproots.

CONTROL OF CRABGRASS AND OTHER COMMON LAWN WEEDS

Steps to take for a weed-free lawn

J. A. DeFrance and A. J. Wisniewski

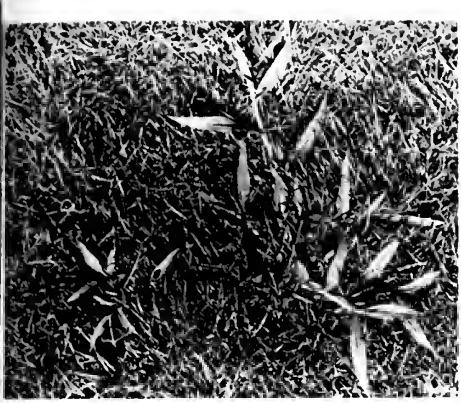
A WELL-KNOWN physician who had a crabgrass problem in his lawn once said that crabgrass reminded him of a cancerous growth. It spreads like the tentacles of an octopus, smothering and crushing the other basic grasses as its growth continues.

Such a comment could not have been truer; crabgrass is the number one enemy weed of lawns and other turf grass areas. It is a summer annual that can be recognized in very late spring and early summer by its short, wide, yellowish-green leaf blades. It also has been called finger grass, summer grass, and water grass. There are a few other weed grasses that in some respects resemble crabgrass. Among these are hairy paspalum, silver crabgrass or goose grass, foxtail, and corn grass or fall panicum.

Two species of crabgrass are quite common: hairy crabgrass (*Digitaria sanguinalis*), and smooth crabgrass (*Digitaria ischaemum*). They are common weeds in lawns and form a fine green growth at first but start late and die in the fall. The two species are similar and are distinguished primarily on the basis of whether the sheath is smooth or hairy. Since they are both annuals, new plants must develop from seed. Smooth crabgrass is by far the most frequent species found in turf in the northeastern states.

What Does Crabgrass Look Like?

The young crabgrass plants become noticeable shortly after the advent of warm weather. Flat stems begin to spread out from the crown and the plants take on their characteristic crab-like ap-



Young and older crabgrass.

Photos courtesy Scott's

Crabgrass finally smothers desirable grasses.

pearance. In late summer and early autumn they appear as a bronze, reddish-purple mat of tangled, wiry, finger-like, seed-bearing stems, many of which stand erect or spread out above the lawn grasses. In closely cut turf, many seed-producing stems lie close to the ground and thus escape the cut of the mowing machine. As the plant matures it becomes very difficult to mow, and produces vast numbers of seeds. A single plant may produce as many as 200,000 seeds. When crabgrass is killed by frost or reaches maturity and dies, it leaves brown and unsightly areas in the turf.

Problems of Control

Unlike other grass seed, all the crabgrass seed does not start to grow at the same time; germination may continue throughout the whole summer whenever conditions conducive to its growth prevail. This prolonged habit of germination poses a rather difficult control problem.

The problem of crabgrass control can be approached in two ways: (1) preventive and cultural methods and (2) chemical methods. When preventive methods fail, and where cultural methods become too time consuming or expensive, then chemical methods are recommended.

Grau

Solid stand of crabgrass. Where turf is thin and summer watering encourages germination, crabgrass takes over completely.

Mature crabgrass plant.

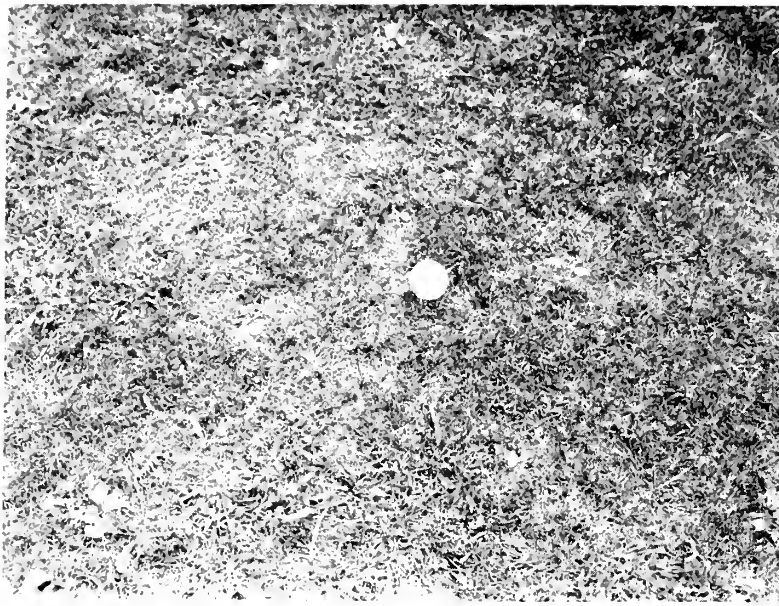
A Good Turf Helps to Control Crabgrass

Let us first consider the preventive and cultural methods. The seedbed should be properly prepared with soil of good structure containing sufficient organic matter to prevent excessive compaction. Foot traffic, heavy rolling, and use of machinery should be restricted to prevent excessive soil compaction particularly after rainfall or irrigation. Diseases and insects should be controlled because they weaken and destroy turf grasses. To prevent grub and earthworm damage an insecticide should be applied to the soil when the seedbed is being prepared. Whenever possible, weed-free seedbeds should be prepared. Excellent results have been obtained at the Rhode Island Agricultural Experiment Station by using calcium cyanamide to obtain weed-free seedbeds. Proper fertilization and liming from the very outset is an absolute must. And above all, let us always remember that the higher price paid for a premium seed is but a small part of the total cost of lawn construction, and that it is impossible to have a good permanent lawn when a cheap seed mixture that contains undesirable grass species is used. These points are all discussed in other articles in this Handbook, but they deserve this further brief emphasis here.

The fact cannot be overemphasized that basic turf grasses should be kept healthy and growing vigorously, for then their resistance to invasion by crabgrass and other weeds will be greater. This, of course, entails the judicious use of fertilizer, lime, and water, and other cultural practices which are beneficial to the grass plant.

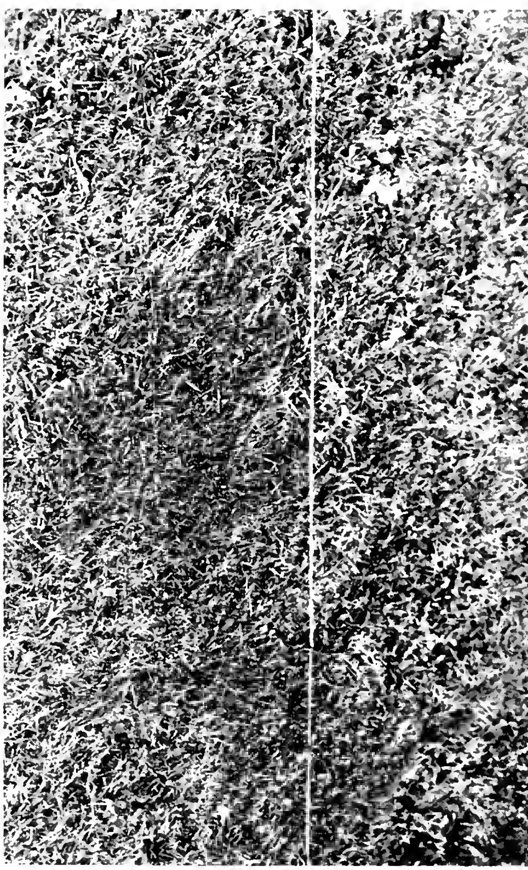
Whenever you are in doubt as to what should be done, contact the county agricultural agent or the agricultural experiment station nearest your home. Their service usually is without charge. They will analyze the soil, and on the basis of the analysis will recommend the proper procedure to follow. Beware of advice given by amateurs and self-professed experts; it may be dangerous and very often is extremely costly.

Thin, poor turf such as this invites the invasion of crabgrass and other weeds.



Once Present, How to Get Rid of Crabgrass

Other cultural measures can be employed if the crabgrass has invaded the lawn. Young crabgrass plants can be pinched out by hand. Older plants with deeper roots require loosening with a knife. Crabgrass seedlings cannot tolerate shade, so some people let the grass grow fairly high during the seedling stage of the crabgrass. After the crabgrass has been brought under control, the height of cut should be lowered so that the plants are mowed off and seed production prevented. Since crabgrass plants have a habit of lying on the ground, raking the turf in several directions before mowing will lift the crabgrass leaf blades, runners, and seed heads so that the mower will get as many as possible. The recently introduced rotary mower does an excellent job of removing stems and seed heads. When crabgrass is seeding, removal of the clippings is essential.



Height of mowing may influence weed invasion. Fescue turf at left, cut at $1\frac{1}{2}$ inches, is comparatively free from weeds; that at right, cut at $\frac{3}{4}$ inch, is being invaded by weeds.

Musser photos

Roche

Spot-spraying with small hand sprayer and chemical weed killers is one method of controlling a light infestation of certain weeds.

Control With Chemicals

If the foregoing preventive and cultural methods fail to control crabgrass, chemical methods are next in order. It must be borne in mind, however, that chemicals are no cure-all. They must be used properly and in conjunction with good management practices.

The discovery of a chemical that would kill crabgrass without injury to the basic lawn grasses has been the goal of researchers for many years. Many chemicals have been tested. Twenty years' search and research have proven the use of the phenyl mercuric acetate complex to be an excellent treatment to eliminate crabgrass in turf. Recent experiments with some of the newer chemicals such as disodium methyl arsonate, disodium benzyl arsonate, and various copper sulfate preparations show that these materia can also be useful in controlling cral grass.

There are two methods for applyin chemical treatments to a lawn: (1) water solution of the chemical is spraye on the lawn, and (2) a dry carrier whic has been impregnated with the chemic is spread on by means of a fertilize spreader.

For the average home owner who doe not own any spray equipment, the use o the dry material is indeed very conven ent although somewhat more expensiv Larger quantities of the chemicals mus be used for dry treatments. Many dea ers in lawn and garden supplies wi either loan or rent the spreader to home owner who wishes to apply the dr material.

Repeat Treatments Needed

If all the crabgrass seeds germinate at one definite time, the plant could b killed in the seedling stage by a singl chemical treatment. But since germina tion of crabgrass seed takes place through out the whole summer and is not fixed t any definite period, post-emergence con trol for a whole season by only one ap plication of any chemical is practicall impossible. Repeated treatments are nec essary to eliminate each successive crop usually two or three are sufficient.

Chemicals for lawn treatment do n differ from medicinal drugs—they shoul be treated with a great deal of respec These chemicals must be used in accord ance with the manufacturer's specifica tions. Too little of the chemical will n give the desired results; greater amount than recommended may result in seriou injury to the desirable turf grasses. Opti mum rates at which weed killers may b used have been determined through th painstaking process of trial and error b manufacturers and at agricultural exper ment stations throughout the countr These rates are usually printed on th package in which the material comes. T avoid disappointing results and seriou injury to the desirable grasses, alway follow the manufacturer's instructions.

Overdose of crabgrass killer has severely injured this plot of creeping red fescue. Attention to manufacturers' recommendations for rates of application is highly important.

Musser

Stopping Seed Germination

Experiments at the Rhode Island Agricultural Experiment Station during the 1955 growing season revealed some new chemicals having the remarkable property of giving pre-emergence (before germination) control of crabgrass. One treatment of the chemical is applied to the soil before the crabgrass germinates. The chemical kills the crabgrass as soon as germination takes place. These materials appear to be stable enough to retain their effectiveness throughout the entire growing season. Although these materials gave effective control of crabgrass during the 1955 season, further testing needs to be done before any recommendations for their widespread use can be made.

Control of Other Lawn Weeds

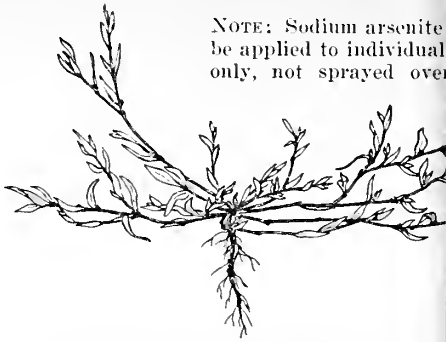
Broad-leaf weeds such as dandelion (*Taraxacum*), plantain (*Plantago*), and field chickweed (*Cerastium arvense*), can be successfully controlled with one or more applications of 2,4-D. Usually weeds with dense mats of foliage need repeated sprayings at intervals of 2 or 3 weeks to reach and cover the leaves which were not injured by the first treatment. Clover, which falls into the broad-leaf category, can be successfully controlled by one or more applications of 2,4,5-T. Since formulations of different manufacturers vary in the percentage of active ingredients it is again strongly recommended that the manufacturer's instructions be carefully observed and the material applied as directed.

When using either 2,4-D or 2,4,5-T reasonable caution should be exercised. These materials are toxic to many vegetables, crop plants, flowers, and shrubs. If sprayed on the lawn under high pressure, the fine droplets can easily be carried by the wind to nearby plantings. Use only low pressure in the spray tank, and apply when there is little or no wind. A sprayer that has contained these chemicals should not be used to spray vegetables, flowers, and shrubs until it has been thoroughly cleaned with strong soapsuds, or with a tri-sodium phosphate solution.

In conclusion, let us be reminded that herbicides, like sleeping pills, should be used with discretion; and that a dense, vigorous, and healthy turf is the best natural enemy of lawn weeds.

NOTE: Sodium arsenite [cut off]
be applied to individual [cut off]
only, not sprayed over [cut off]

Annual bluegrass (*Poa annua*)
Control: difficult, sodium arsenite helps



Knotweed (*Polygonum aviculare*)
Control: 2,4-D or sodium arsenite

Purslane (*Portulaca oleracea*)
Control: cultivation, 2,4-D

Spotted spurge (*Euphorbia maculata*)
Control: 2,4-D or sodium arsenite

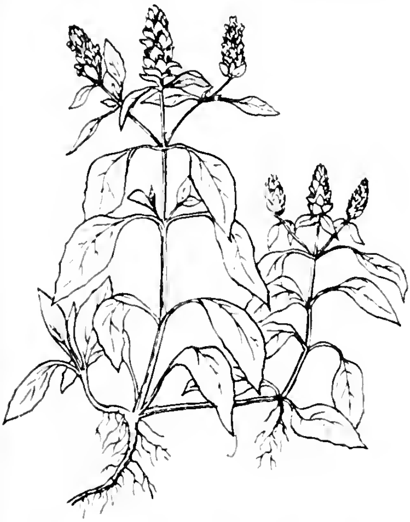
Broad-leaved plantain (*Plantago major*)
Control: 2,4-D

Goose grass (*Eleusine indica*)
Control: same as crabgrass, see text

12 COMMON

Ground-ivy (*Glecoma hederacea*)
Control: 2,4-D or arsenicals

Mouse-ear chickweed (*Cerastium vulgatum*)
Control: 2,4-D or arsenicals



Heal-all (*Prunella vulgaris*)
Control: 2,4-D or arsenicals

Common chickweed (*Stellaria media*)
Control: 2,4-D or arsenicals

Quackgrass (*Agropyron repens*)
Control: handweeding

Buckhorn plantain (*Plantago lanceolata*)
Control: 2,4-D

LAWN WEEDS

LAWN GRASSES AND MIXTURES

What kind of grass seed should one buy?

Alan F. Mock

GOOD grasses do not appear in the lawn by accident, although sometimes when we compare our own lawn with that of our neighbor, we are tempted to think so. No lawn, anywhere, is the result of a miracle which overnight produces a luxuriant velvety carpet of beautiful grass. Good lawns can result only from the application of a relatively few but very important basic principles to every step of construction and subsequent maintenance.

Dependable Grasses

Among these basic facts, none is more vital to the final result than the kind of grass that is chosen. The best soil and most perfect preparation will not produce a good permanent lawn if the grass or mixture of grasses to be sown are not fitted for the job.

If there were a large list of lawn grasses, the determination of what to use might be quite complicated. Actually, it is reasonably simple because of the relatively few kinds that deserve consideration. Usually, there are not more than three or four grasses that can be depended upon to produce top-quality turf in any particular locality. In the cool, humid region (the northeastern and north central section of the United States), to which this discussion is confined, the bluegrasses (Kentucky and rough-stalked blue), the fescues (creeping red and Chewings), and the Colonial bents (ASTORIA and HIGHLAND), are about the only grasses that can be depended upon to make good permanent lawns, in anything like reasonable time and with reasonable effort.

No, these are not the only grasses that will make a green lawn cover. Ryegrasses will do so for a limited time (2 or 3 years at the most) and then will die out, with clover, crabgrass, or other weeds coming in. Redtop will do it—also for only a relatively short time. Tall meadow fescue and even timothy will make a green cover, but they are coarse and make a bunchy, open turf that never looks well, even after it has just been cut. All of these grow faster than bluegrass and red fescue. It is not uncommon to see a lawn seeded with these coarse grasses and the first year they develop faster and may look better than a bluegrass, fescue, or bent seeding. They are cheaper, and most of the low-priced seed mixtures carry high percentages of one or more of them. Since they will do no better on poor soil than the permanent good turf grasses, and need practically the same attention as to fertilization, watering, and cutting, the only important remaining consideration is first cost of the seed. Sometimes, that must be the deciding factor in our choice. We cannot all afford the finest motor cars, and we drive what our pocketbooks will stand. But we should at least know what we are buying and not expect permanency and top quality from mixtures composed largely of grasses that cannot supply these things.

New Varieties That Are Good

Actually, there is somewhat more of a choice of good grasses than just Kentucky bluegrass, fescues, or bent—new varieties of these old standbys are available. What

A well managed Kentucky bluegrass lawn.

This excellent turf results from planting a mixture of Kentucky bluegrass and Colonial bent.
Noer photos

MERION strain of Kentucky bluegrass makes a superior lawn. This relatively new variety is resistant to leafspot, but in some areas suffers from stem rust (see page 123). It does best if cut at about an inch, and watered sparingly.

justifies the claim of a new variety to superiority? The answer is quite simple—it must be at least as good as the standard parent variety from which it came in all of the important characteristics that make for good turf quality, and significantly better in at least one. In the past few years several new varieties of Kentucky bluegrass have been developed. The MERION variety is probably the best known of these. During the same period at least two new varieties of red fescue have been found—the ILLAHEE and PENNLAWN strains. Are these new varieties any better than the parent types from which they come?

The average home owner has neither the time, the inclination, nor the opportunity to determine the possibilities of a new variety. Usually, his best source of information is his state agricultural experiment station. If a grass variety is a legitimate new development the experiment station will have it under test or at least know about it several years before it is in commercial production. If they do not know about a new variety it would probably be wise to let it alone until some authentic information is available. MERION Kentucky bluegrass, and ILLAHEE and PENNLAWN red fescues have been subjected to repeated critical tests at a number of experiment stations during the last five years. There is little doubt that they have the ability to produce better quality turf than the common Kentucky bluegrass and red fescue parents from which they originated.

Why Mixtures?

This brings us to the all-important question, "What kind of grass seed shall we buy?" The man or company selling the seed also has a real stake in the answer. He not only must provide seed that is within the cost range of what people can afford to pay, but also he must take into consideration the very important fact that the seed will be planted under all sorts of conditions.

Now when an automobile dealer sells a car, he can generally be sure that he will not be held responsible should the auto run out of gas, break an axle because it is driven over a railroad trestle, or otherwise handled in a manner for which it was not designed.

The seedsman, on the other hand, can feel pretty confident that, no matter what may befall the lawn that may or may not result from the seed he sells, he *will* be held responsible. This is because most consumers are not acquainted with the whys and wherefores of lawn construction and maintenance.

Seedsmen prefer to sell grass mixtures. In their experience, the mixture meets the practical needs of the home owner better than seed of a single variety.

The reason for the popularity of mixtures is twofold. First, should conditions be unfavorable for one of the grasses in the mixture, the others will take over the area and a lawn will result even though one of the ingredients failed to grow. Second, very often the faster-growing grasses will grow at once and protect the area from weed invasion while slower-germinating grasses are getting a start. This may or may not be a virtue. If too much of the fast-growing seed is present it may smother the slower-growing, more desirable grasses.

The most important consideration is, "What types of grasses are contained in the mixture?" Some grasses cost ten or more times what others do, but may be worth a thousand times more when it comes to doing the job desired.

Study the Label

State and Federal Seed Laws require seed mixtures to be clearly labeled in respect to contents and the ability of these contents to grow. The date of test must also be shown on the label. The seed purchaser should carefully scrutinize the label on the seed packages; it is an infallible guide to the value of the mixture.

The only way to read an analysis label intelligently is to become acquainted with the characteristics of the various commercial turf grasses. In order to make this information as brief as possible, it is given in tabular form at the end of this article on page 116.

The table does not indicate normal germination time, but the grasses have been arranged roughly in order of speed of germination, with the slowest-germinating at the top. The following information must be on the label:

Percentage of pure seed. The figure given for this percentage represents the proportion of pure seed per pound that is actually in the mixture. For instance, the seedsman may have had to put in 60% of standard purity bluegrass seed to show 50% pure seed on the label since "standard purity" is not itself 100% pure seed. You would not achieve the same result by buying half a pound of standard purity seed and planting it over the same area.

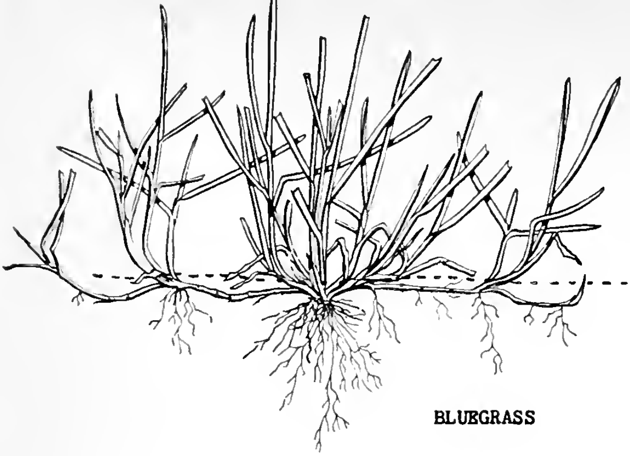
Germination. The ingredients are actually tested in a licensed seed laboratory under rules and techniques established by the United States Government. These tests show what percentage of the seed will produce a live, healthy seedling under *favorable* conditions. This does not mean that the same results will be obtained if the seed is thrown on dry clay in July.

Weeds. No matter how carefully grown and refined, grass seed generally contains a small percentage of weed seed, and this must be shown. Generally this will not exceed 3/10%, and may be lower. It is often true that the weeds present are not the type that will survive mowing anyway, so in this event the weed content is not generally significant. It should be pointed out that the most pestiferous weed, crabgrass, is almost never present in seed mixtures.

Crop seeds. The law requires that any other seed of commercial value in a percentage of less than 5% must be shown as "Crop Seed." Red clover or corn would be an example. While this is seldom a factor, buying a mixture with more than 1% of crop seed is not recommended.

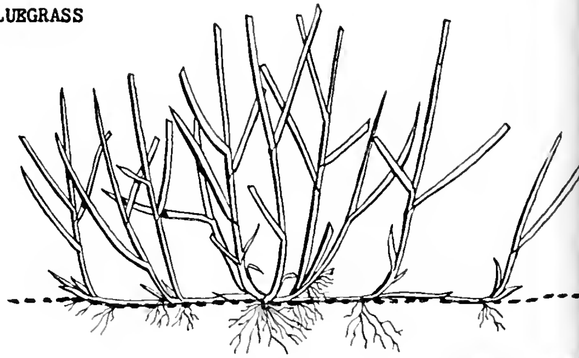
Inert matter. This consists of anything that will not grow. It usually comprises

Bluegrass and the creeping red fe
spread by creeping stems (rhizo
just underground.

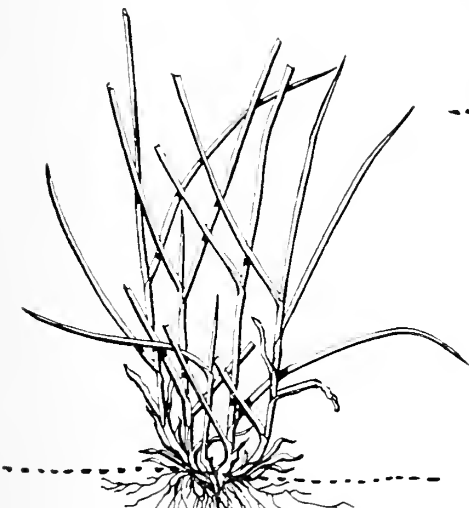


BLUEGRASS

The stolons of creeping bent spread at the surface of the ground.



BENTGRASS



The non-creeping lawn grasses such as Chewings fescue and redtop branch at the crown (called "tillering").

Drawings courtesy Scott's

A good seed package label tells exactly what is in the mixture and the guaranteed germination of each kind of seed.

PERCENT	KIND	GERM.
43.20	Merion Bluegrass	80%
14.85	F74 Fescue	90%
14.75	Illahee Fescue	90%
14.50	Poa Trivialis	85%
9.90	Colonial Bentgrass	90%
0.10	Weeds	
2.70	Inert Matter	
Lot SM-12	Tested: Feb. 1956	

CAUTION: MAY CAUSE IRRITATION OF EYES, NOSE OR THROAT IF ALLOWED TO COME INTO DIRECT CONTACT WITH THESE PARTS. WASH AFFECTED AREA PROMPTLY AND THOROUGHLY WITH WARM WATER.

chaff, empty seeds, pollen, bits of dust, and other material of that nature. High percentage of inert matter does not basically harm the seed, although it does mean that you are paying for something that will not grow.

Date of test. It is illegal to sell seed after a certain period of time—generally 9 months after the date of test. This does not mean that the seed will not grow; it merely means that another test and a new label are required. Normally, the germination will decrease slowly over a period of years, depending on the individual lots of seed and the storage conditions. There is nothing whatever wrong with "last year's seed", although it should carry a new analysis based on current germination percentages. One rather odd quirk of seed technology is that in buying seed in the later summer for fall planting, it is sometimes preferable to purchase seed dated January than seed dated August. Some types of seed do not grow as well when freshly harvested as they do after they have been stored for a while.

Schery

Bluegrass (right) and ryegrass (left) seed. A pound of bluegrass seed costs more, but contains up to eight times as many seeds.

Buyers' Guide Rules

It is not to be expected that everyone who embarks on a lawn construction program will make himself a turf grass expert. But even for those who do not wish to go to the trouble of acquainting themselves with the major grasses and their uses, the following is a sound set of guide rules for buying grass seed mixtures:

1. Do not buy the cheapest unless you want a temporary lawn. Buy the best you can afford, except when planting in the late spring or early summer.

2. Use varieties that are best adapted to your region, or to the special use you are planning for them.

3. Avoid grass seed that features sensational claims.

4. Avoid grass seed that "hides" the analysis. A seedsman is proud of good seed.

5. Select seed that is cleanly packaged, and is furnished with complete planting instructions.

6. Most good seed companies furnish lawn maintenance booklets. Ask your dealer for one. Better yet, follow the expert advice in this Handbook!

7. Do not depend upon your neighbor for advice; you will usually just repeat his mistakes.

8. Realize that the seed is only part—though a vitally important part—of the process of establishing a good lawn. Be sure to follow carefully all other establishment procedures to get the most out of good seed.

9. When in doubt ask your state agricultural experiment station or some other well recognized authority (see PLANTS & GARDENS, Spring 1956, pp. 20 to 23 for list and addresses of stations).

CHARACTERISTICS OF GRASSES FOR LAWN TURF

Germination	Grass	Life Span in Lawn	Soil Requirements: Fertility	Soil Requirements: Drainage	Moisture Requirements	Texture	Height of Cut	Habit of Growth	Number of Seeds per Pound
Slower Germination ↑	Kentucky Bluegrass (Includes MERION and other new varieties)	Permanent	Rich and sweet	Good	Moderate	Medium	1¼″ to 2″	Creeping	2 to 2¼ million
	Creeping Red Fescue (Includes ILLAHEE and PENNLAWN)	Permanent	Moderate	Good	Low	Fine and wiry	1¼″ to 2″	Creeping	500,000 to 600,000
	Chewings Fescue	Permanent	Moderate	Good	Low	Fine and wiry	1¼″ to 2″	Non-creeping, bunch	500,000 to 600,000
	Tall Fescue (Includes ALTA, KY-31, and Meadow)	Permanent	Moderate	Good	Low	Coarse	1½″ to 3″	Non-creeping, bunch	400,000 to 500,000
Faster Germination ↓	Colonial Bentgrass (Includes HIGHLAND and ASTORIA)	Permanent	Rich	Fair	High	Fine and soft	¼″ to ¾″	Bunch to creeping	6 to 7 million
	Rough-stalked Bluegrass (*Poa trivialis*)	1 to 3 years	Rich and sweet	Good	High	Medium	1¼″ to 2″	Creeping	2 to 2¼ million
	Ryegrass (Includes common, Italian, and perennial)	1 to 2 years	Rich and sweet	Good	Moderate	Coarse	1½″ to 2″	Non-creeping, bunch	250,000 to 300,000
	Redtop	1 to 3 years	Moderate	Fair to poor	Moderate	Medium-coarse	1″ to 2″	Non-creeping	6 to 7 million

INJURIOUS INSECTS OF TURF GRASSES

How to recognize and control them

J. O. Pepper

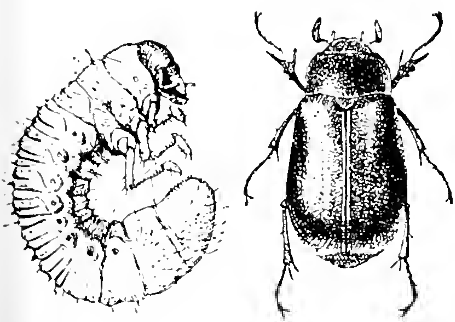
SUCCESSFUL control of turf-infesting insects depends largely upon recognition of the infestation in its early stages and accurate identification of the insects involved. In view of this fact, it is important that home owners, gardeners, and others charged with the responsibility of maintaining high quality turf be able to detect the first signs of insect activity and, whenever possible, anticipate outbreaks and thereby prevent them. If the problem is unusual, get advice from your county agricultural extension office or state agricultural experiment station.

White Grubs

Included in this group are the worm (larval) stage of Japanese beetle, also May and June beetles, Asiatic garden beetle, Oriental beetle, and masked and European chafers. These grubs feed on the roots of grasses. They are thick, sluggish, white-bodied worms with yellowish-brown heads and legs and are from 3/4 to 1 1/2 inches long when full-grown. Their injury causes the turf to become loose and dead or stunted in brown scorched areas that may be lifted or rolled up easily. Birds, moles, and skunks may dig up the turf in search of them as food.

May beetle. Left, white grub (immature stage). The adult is also called June beetle or June bug; it is dark brown, flies mostly at night.

Courtesy U.S.D.A.



Control. White grubs are controlled by chemically treating the soil where turf grasses are grown. A single treatment will offer protection from grub injury for 3 to 5 years. Any of the insecticides shown in the table may be used.

Amounts of Various Insecticide Formulations to Use

Insecticide	Form	Amount needed for 1000 sq. ft. (10 ft. x 100 ft.)
Aldrin		
	25% WP*	5 1/3 ounces
	2% Granular	4 pounds
	23% Emulsion	1/3 pint
Chlordane		
	40% WP	10 ounces
	2 1/2% Granular	10 pounds
	72% Emulsion	1/4 pint
Dieldrin		
	50% WP	2 1/2 ounces
	5% Granular	1 1/2 pounds
	15% Emulsion	1/2 pint
Heptachlor		
	25% WP	5 1/3 ounces
	2 1/2% Granular	4 pounds
	23% Emulsion	1/3 pint

*Wettable Powder

Noer

Lawn damage by May beetle grubs.

Courtesy U.S.D.A.

Sod turned back to show heavy grub infestation underneath.

Applying dry insecticide mixed with sand or organic fertilizer.

Courtesy U.S.D.A.

Application of Soil Poisons. These materials may be applied any time of the year when there is no frost in the ground; however, applications made in late April or August are usually favored.

Any of the insecticides may be mixed thoroughly with organic fertilizer or sand and distributed in a spreader. The wettable powder or emulsion form of the insecticide may be mixed with water and sprayed or sprinkled on the area. About 10 gallons per 1000 square feet are generally recommended. When used as sprays, the mixture should be constantly agitated.

All of the insecticides must be watered into the soil soon after application. This can be done by sprinklers or the material can often be applied just prior to a rain.

Keep children and pets off treated areas until the material is watered in and the grass is dry.

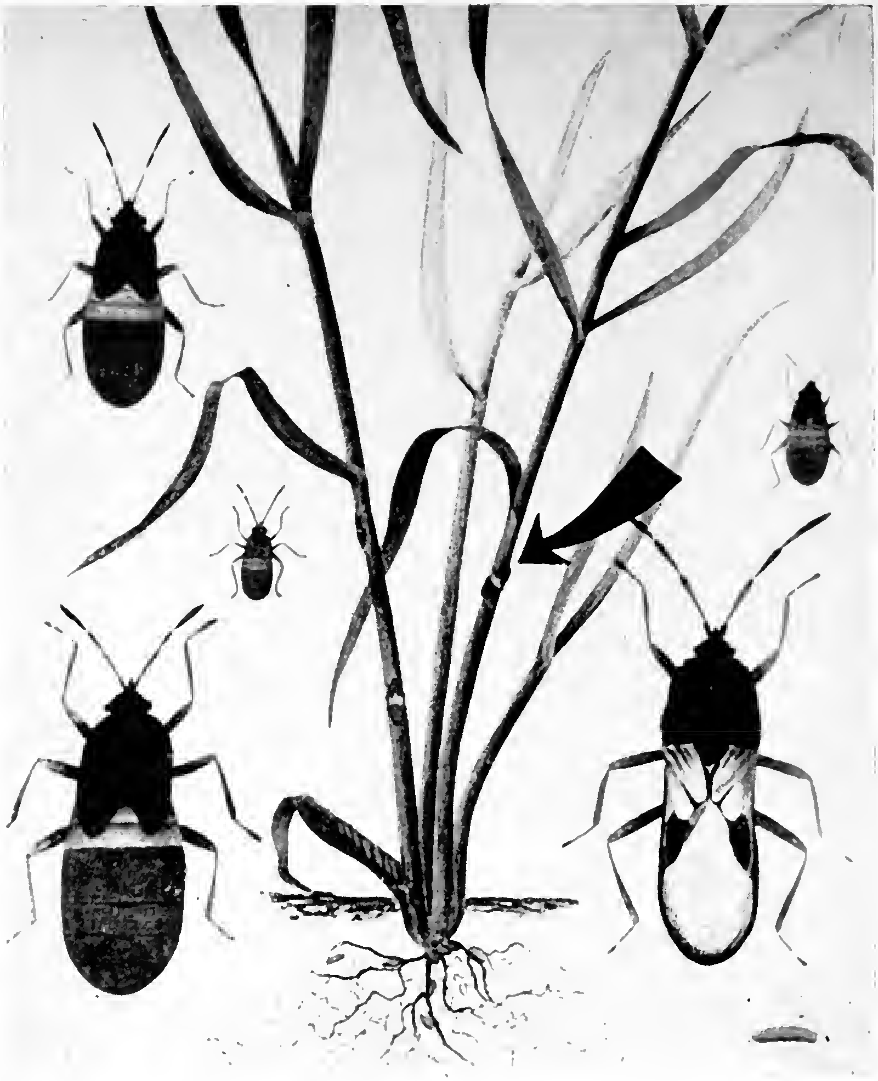
A spore-forming bacterium that attacks and kills a high percentage of Japanese beetle grubs is known as **milky disease.** After treating an infested area with spore dust, it usually takes several years before it becomes well-established and any great reduction in grubs is noticed. A single treatment of infested turf will usually insure the establishment of the bacteria.

The milky disease spore dust is available commercially with directions for its use. This may be purchased and applied by individuals wishing to use this method of grub control.

Cutworms

These worms are the larval stages of fairly large-sized night-flying moths, often called "owlet moths." Cutworms are smooth, nearly naked caterpillars varying in length from 1 to 2 inches when full-grown. They are usually dull-colored and indistinctly marked with spots and longitudinal stripes. They appear any time from spring until late summer. Cutworms feed mostly at night, chewing off the grass leaves and sometimes the entire plant stem. Their injury is much more conspicuous on fine turf grasses such as golf greens. Here the injury appears as small winding tunnels or trails of dead grass. The trails may be 6 inches or more in length. When abundant, cutworms can do severe damage to fine turf grasses.

Control. Use 1 measuring cup of the wettable powder form of either Chlordane 40%, Dieldrin 50%, DDT 50%, or Heptachlor 25% in 20 gallons of water and thoroughly sprinkle or spray into 1000 square feet of the infested areas. Applications may be repeated as needed.



Stages in development of chinch bug. The young are at first reddish in color, turning brownish, with white band across back. Adults are black with white wings that extend to tip of body. Hairy chinch bug, especially damaging to eastern lawns, has short wings. Arrow points to insect feeding on grass stem.

Courtesy Illinois Natural History Survey

←

Larva and moth of sod webworm.

Courtesy U.S.D.A.

Lawn damaged by chinch bug. Dark, undamaged spots are white clover; the grass is all dead. Bentgrasses are particularly vulnerable to chinch bug infestation, but bluegrass and other fine lawn grasses are not immune.

Sod Webworms

In habits and injuries these worms are fairly similar to the cutworms, but are only about one-half their size. They feed in the same way as cutworms but their tunnels or trails are lined with silk-like webs, giving them their common name of "webworms." Bird feeding activity on lawns, golf greens, or other turf areas often indicates an infestation of either cutworms or webworms, or both.

Control. Use one of the insecticides as listed for cutworms.

Chinch Bug

These insects are frequently serious pests on fine turf grasses, lawns, and golf courses. The adults are about 1/5 inch long and have black bodies with white wings. The young, or nymphs, are lighter colored, being yellowish or reddish, marked with white. In Pennsylvania two generations occur per year, the first in June and the second in August. The injury appears as irregular brownish areas of dying grass. This is caused by the chinch bugs sucking the sap out of the stem of the plant at the ground level.

Control. Use one of the insecticides as listed for cutworms. Application should be made at the first signs of injury. Usually an application is needed for each generation, that is, the first one in June and the second in August. The insecticide must be applied thoroughly and with sufficient force to wet the soil surface at the base of the grass plants.

Ants

Ants are found in practically all soils and frequently become troublesome pests on golf courses and home lawns. They may build up small hills of soil or sometimes large mounds according to the kind of ant present.

Control. Where ant hills are numerous use 1 measuring cup of the wettable powder form of Aldrin 25%, Chlordane 40%, Dieldrin 50%, or Heptachlor 25% in 20 gallons of water and thoroughly sprinkle or spray onto 1000 square feet of infested area. The materials will be more effective if watered into the soil soon after application. Spot treatment can be used to kill the ants in a few scattered, small hills by spreading a teaspoonful of any of the above insecticides over the entrance of the ant hill and washing it into the soil with water.

LAWN GRASS DISEASES

How to recognize common diseases of lawns and best methods for controlling them

William Klomparens

MOST green plants, including lawn grasses, are susceptible to disease. Many "diseases" are physiological, i.e., their symptoms are caused by improper fertilization, or lack of fertilization. But the diseases to be mentioned here are caused by parasitic fungi. The diseases described and illustrated are those known to be prevalent on the more commonly grown lawn grasses in the northern half of the United States (Colonial or creeping bents, bluegrasses, and fescues). The lawn enthusiast striving for a perfect lawn area has undoubtedly been amazed at the loss of turf and disfiguration caused by these diseases. They are an ever-present threat and are easily transported by the wind, splashed about by rain, or carried around on such implements as lawn mowers, or even on shoes!

Fungi lack chlorophyll (the green coloring of familiar plants), and so cannot synthesize their own food; therefore, they are dependent upon other organic materials as a source of nutrients. Those which obtain their food from decaying fallen leaves, branches, and other crop residues are of inestimable value. Another group, the parasitic forms dealt with in this article, may obtain most of their nutrients from living plants. These can cause tremendous losses when the weather conditions favor infection and destruction of economic plants. Each of these parasites is favored by a rather specific combination of temperature, humidity, and host plant. This usually restricts their occurrence to certain growing periods, making their identification and control a little easier.

Diseases of Common Occurrence

Bluegrass Leafspot (*Helminthosporium vagans*). Bluegrass leafspot symptoms first appear on the grass blade as small brown specks which gradually enlarge to form circular to elongate purple spots. These spots may enlarge and extend across the leaf blade, with the tissue in the center of the affected area becoming straw-colored or white. Surrounding this straw-colored area is a border of dark brown- to black-colored leaf tissue. In severe cases the crown (main stem) of the plant may become invaded and cause the leaves to wither and the individual plant to die. When the crown of the plant is invaded and turns brown, the condition is commonly called "foot rot." The most extensive damage to the turf is due to this stage of the disease and will result in a severe thinning of the turf area.

Severe leafspot occurs during early spring and late fall, although the fungus may cause some damage throughout the entire growing season. In the months of April and May prevailing cool, wet weather favors infection by the parasitic fungus. During this period the grass may be attacked and weakened considerably, although visible loss of turf may not occur. In late May and early June, hot weather combined with a reduction in the amount of rain causes the weakened, infected grass parts to wither and die.

Another condition favoring infection is an excessive amount of nitrogen combined with close clipping during the cool wet

period when infection is occurring. A temperature range of 55° to 60°F. favors the disease.

Control. Experimental work indicates that spring and fall applications of antibiotic preparations and the organic forms of mercury are of value in controlling this disease.

Snow Mold (*Fusarium nivale* and *Typhula* spp.). Snow mold occurs with abundant moisture and temperatures ranging between 40° and 60°F. This injury generally occurs as snow is melting in the early spring, or during midwinter thaws. Snow is not a prerequisite to the snow mold disease but usually provides ideal moisture and temperature for disease development. Starting in a small spot of lawn that first shows up when 1 to 2 inches in diameter, the fungus spreads outward as a white, blue-gray, or almost black growth. Generally, the maximum area affected is 2 feet in diameter.

Control. Snow mold is controlled by applying organic and inorganic mercury compounds or some organic sulfur compounds just prior to the expected permanent snow cover and possibly again during midwinter thaws.

Merion Bluegrass Rust (*Puccinia graminis*). Most bluegrasses are susceptible to rust, but the disease is rare except on the newly developed MERION bluegrass. Rust infection may be expected as early as June in some of the central states and as late as August or September in northern locations. The earliest visible symptoms are tiny yellow flecks on the individual grass blades. These soon progress to form definite pustules (blisters) which produce masses of reddish spores. Severe infection causes the entire affected area to take on a reddish cast. These spores may collect on shoes as a noticeable red deposit when one walks through the area.

Control. Although final details on the control of this disease have not been worked out, recent work at Rhode Island and Pennsylvania State Universities indicates that antifungal antibiotic preparations are very promising. In Pennsylvania, two applications at 15-day intervals retarded turf growth slightly but furnished essentially perfect control.

Note: Organic mercury compounds have been reported to damage MERION bluegrass.

Kentucky bluegrass leafspot symptoms. Right, typical leaf injury, left, purple-black streaking of "foot rot" stage.

Leafspot of bluegrass is caused by *Helminthosporium fungus*, shown here growing on blade of grass, several hundred times magnified. Oblong bodies are spores which break off and are carried mechanically or by wind to other plants, where they start infection.
Author photos

Author photo

Grease spot (*Pythium fungus*) damage on turf has water-soaked smoky appearance, is favored by high temperatures and humidity.

Dollar Spot (*Sclerotinia homoeocarpa*). This disease occurs during the cool, wet periods of spring and fall; and although it may attack many lawn grasses, it is most prevalent on bentgrass areas. Tiny yellow spots appear on individual grass blades. These blades soon become bleached as the infected lawn area enlarges to about 1½ inches in diameter. The spots, bleached an off-white color, are approximately the size of silver dollars, thus the descriptive term "dollar spot." The grass in these very restricted spots may be killed down to the roots.

Control. Dollar spot is particularly prevalent on the bentgrasses, but is not considered to be one of the most serious turf diseases as it is relatively easily controlled by turf fungicides. The recommended turf fungicides are antibiotic preparations, cadmium compounds, chromate compounds, and mercury (organic and inorganic forms). Fair results are sometimes obtained from certain organic sulfur compounds.

Fading-out (*Curvularia* spp.) is a relatively new disease which is particularly prevalent on velvet and other creeping bentgrasses, also on MERION bluegrass. It occurs during the summer months and produces irregular to angular reddish-brown areas. The maximum length or width of affected turf areas will rarely be over 3 inches, but individual spots may join and form a snaky or sinuous pattern several feet in length.

Control. Recommended chemicals for control are the antifungal antibiotic preparations or organic mercuries.

Grease Spot (*Pythium* spp.). Pythium is favored by extremely high humidity and relatively high temperatures, generally higher than 85°F. The early symptoms may resemble several other diseases, including brown patch and possibly dollar spot. As the disease progresses it is found to be roughly circular and water-soaked or smoky-appearing. If high temperature and humidity continue, these areas

may remain circular areas, coalesce, or form streaks which usually follow depressions and surface water runoff.

Control. Pythium control by fungicidal chemicals is still in the experimental stages, but recommendations are almost certain to appear very shortly. Relief has been obtained from light dustings of lime.

Damping-off (*Rhizoctonia, Pythium, Fusarium*, etc.). The term damping-off is confined to a disease condition which affects *only* germinating seed or seedling plants, whether they are grasses or other green crops. In turf areas damping-off may be caused by numerous organisms including *Pythium, Pellicularia* (*Rhizoctonia*), *Fusarium*, and others. Large irregularly-shaped areas in newly seeded lawns may be almost completely destroyed. The condition usually is associated with excess water but may be aggravated by a fluctuating water supply. Early summer or summer seedings are often the most severely affected, although grass seed planted at the recommended periods of fall and spring may also suffer from damping-off.

Control. Because of the many organisms involved, chemical controls are not completely satisfactory. Certain organic sulfur compounds often control several of the organisms involved in the disease. Seed treatment is economical insurance but will not necessarily eliminate damping-off.

Brown Patch (*Pellicularia filamentosa*). True brown patch occurs when the relative humidity approaches 100% and night temperatures remain 70°F. and above. It is characterized by a roughly circular "smoke ring" surrounding the noticeably damaged area which may range from a few inches to 2 feet or more in diameter. Brown patch is particularly severe when excess nitrogen has made the grass succulent. Leaf and root rotting are apparent within the "smoke ring" but complete destruction of the turf within the ring is unlikely.

Control. Recommended controls for brown patch would include regular applications of the newer antifungal antibiotic preparations, chromate compounds, mercuries (organic and inorganic forms), and organic sulfur materials.

Fairy Ring (*Agaricus, Marasmius*, and others). Fairy rings are caused by soil-inhabiting mushrooms or toadstools which, according to the best theories, are effective competitors for nutrients and may form a mat beneath the soil which interferes with water movement. The early symptoms are deep green-colored rings. The turf in this deep green area may eventually die and the ring will move outward as the disease progresses. Mushrooms may or may not appear in a ring depending upon the frequency and height of mowing.

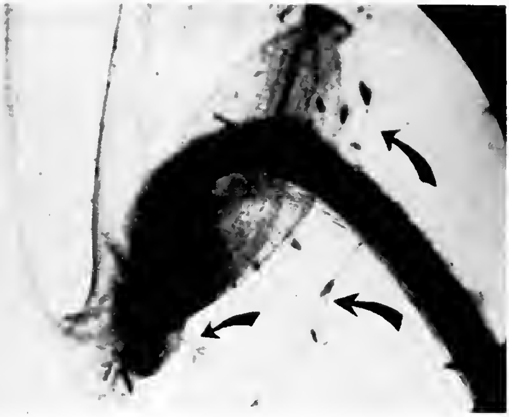
Control. There are no known satisfactory controls for fairy ring. California investigators suggest trials of magnesium products such as dolomitic limestone and Epsom salts. Other turf experts suggest the use of adequate nutrients, while still others recommend that small fairy rings be dug out completely and replaced with fresh soil and turf.

Miscellaneous Diseases

Other diseases that occur on lawn grass areas but are not as commonly found as those previously listed and illustrated:

Melting-out (*Helminthosporium sativum*) is a relatively newly discovered disease which has caused severe killing of creeping bentgrass in large areas of golf putting greens but to the present has not been prevalent on bentgrass lawn areas. The affected areas at first have a smoky-blue cast and later become yellow just before the plants are killed. On occasion, yellowing and the death of the plants occurs in the absence of the smoky-blue cast. Because of extensive root-rotting the plants within the affected area fail to recover. High humidity (90% and up) and daytime temperatures of 75°F. and up are known to favor the development of this disease. The recommended control is repeated applications of the antifungal antibiotic preparations.

Copper Spot (*Gloeocercospora sorghi*) causes symptoms similar to that caused by dollar spot except that the small areas of roughly 1 inch in diameter are a true



The fungus that causes melting-out disease of creeping bentgrass, is *Helminthosporium sativum*, on grass seedling. Fungus grows through tissues and sends out branching threads (see arrows).

copper color instead of bleached as in dollar spot. Recommended controls include cadmium compounds and the organic and inorganic forms of mercury.

Pink Patch (*Corticium fuciforme*) occurs during warm, humid weather and causes grass blades in the affected area to be matted together by the definitely pink vegetative growth (mycelium) of the fungus. The favored chemical control is the use of organic mercury compounds.

Algae may also cause some damage to turf areas. Turf-damaging algae are true green plants. They possess chlorophyll and are related to the commonly observed forms seen in slow-moving streams, stagnant ponds, and other moist locations. They are not true parasites but are effective competitors for nutrients and as they increase in numbers tend to smother the turf. After the turf has been killed and the moisture has evaporated or drained away, the algae mat together and form a black paper-thin sheet over the affected area. Damage from algae may best be prevented by adequate water drainage. Dilute copper sulfate sprays have been used with some success but care should be exercised when using copper since a copper accumulation may in itself be toxic to turf.

General Control Recommendations

Although the use of chemicals for the control of turf diseases is often necessary, it should in no way replace maintenance practices which aid in the prevention of disease. Recommended practices for proper water drainage, fertilizer usage, and height of cut will do much to prevent serious disease outbreaks. When disease is suspected on a lawn area, the following steps are suggested:

1. Probe the affected areas for grubs, sod webworms, or other insects. If no insect life is found

2. Attempt to identify the disease or have it identified by an authority.*

3. Select the proper chemical material, apply it thoroughly at the rate and interval suggested by the manufacturer.

4. Attempt to determine the contributing management factors such as excessive water, inadequate air circulation, or nutritional deficiency. These basic factors should be corrected if possible.

There is a wide choice of fungicides recommended for the control of turf diseases. The best selection is probably to be found at golf course supply houses. In alphabetical order these main categories are: antifungal antibiotic preparations, cadmium compounds, chromate compounds, mercury compounds (organic and inorganic forms), and sulfur (certain organic forms). Applications of lime and copper sulfate are of value for specific disease conditions.

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*See Plants & Gardens, Spring, 1956, pp. 20-23 for list of State Agricultural Experiment Stations who perform such services free or for a nominal charge.

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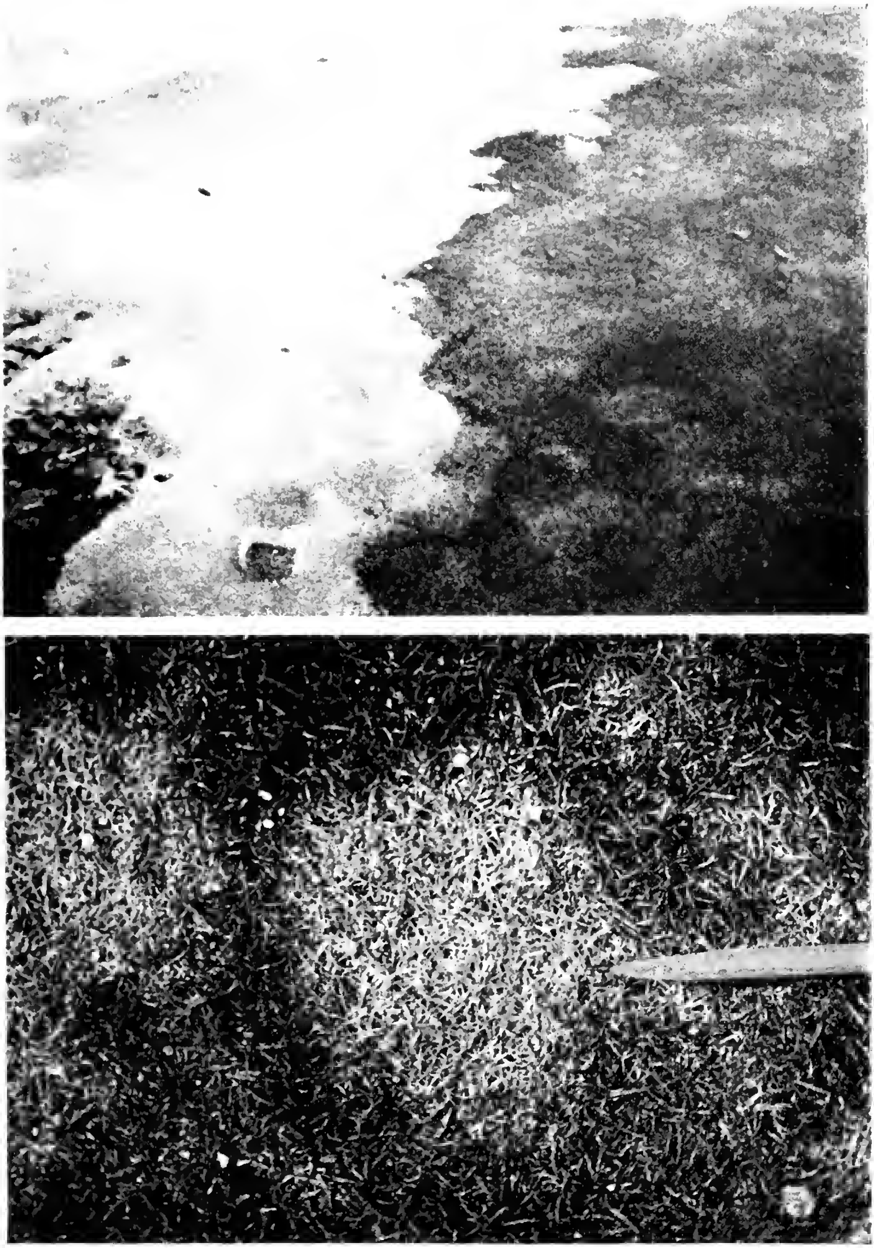
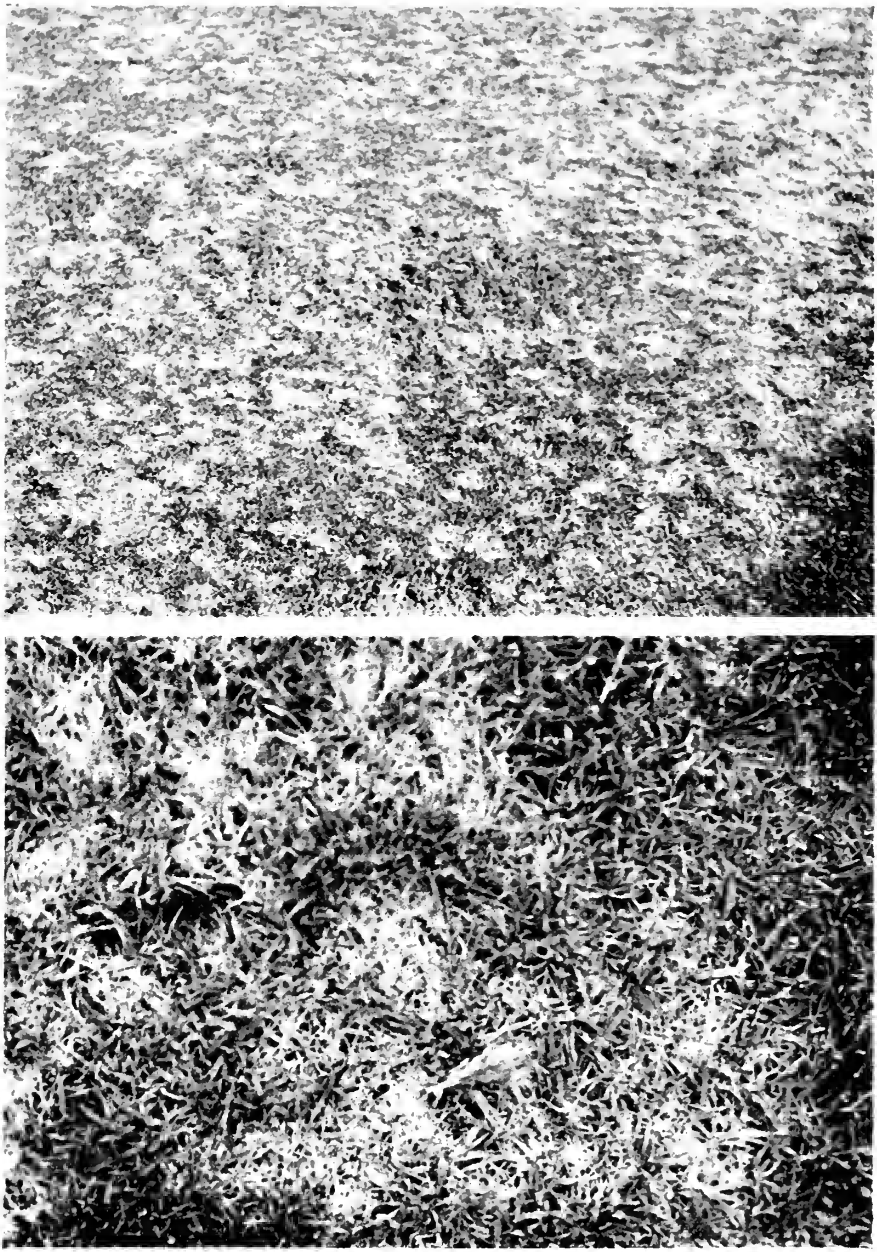


Photos courtesy University of Rhode Island Experiment Station

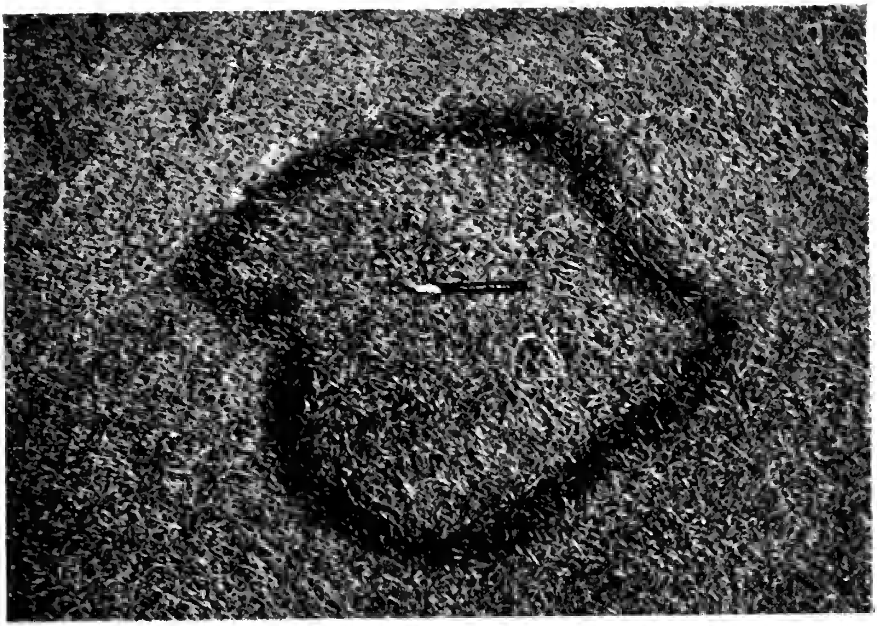
Color plates courtesy Mallinckrodt Chemical Works

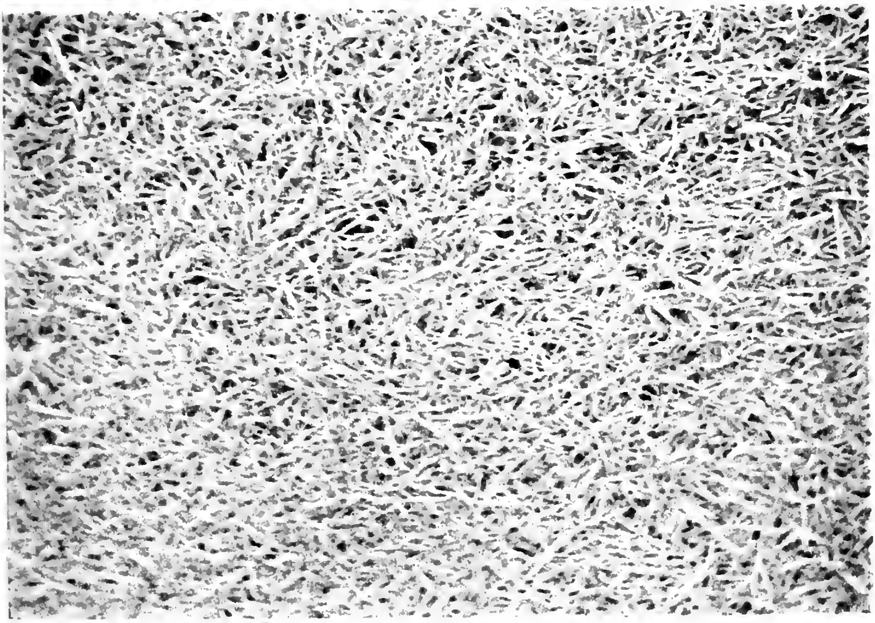
Top. Snow scald injury as snow melts.
Bottom. Snow scald fungus on Seaside bent.



Photos courtesy University of Rhode Island Experiment Station

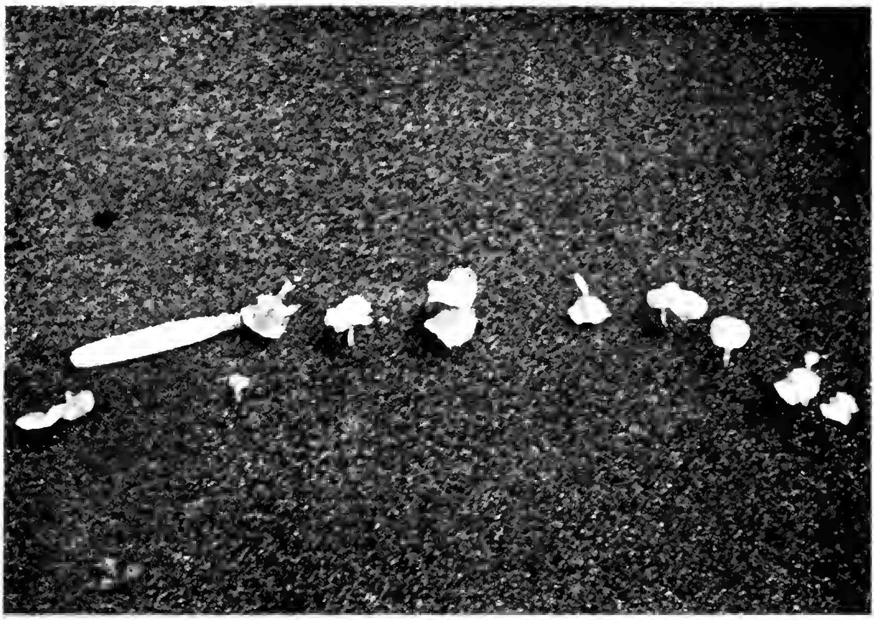
Top, Dollar spot injury of creeping bent.
Bottom, Dollar spot mycelium killing turf.

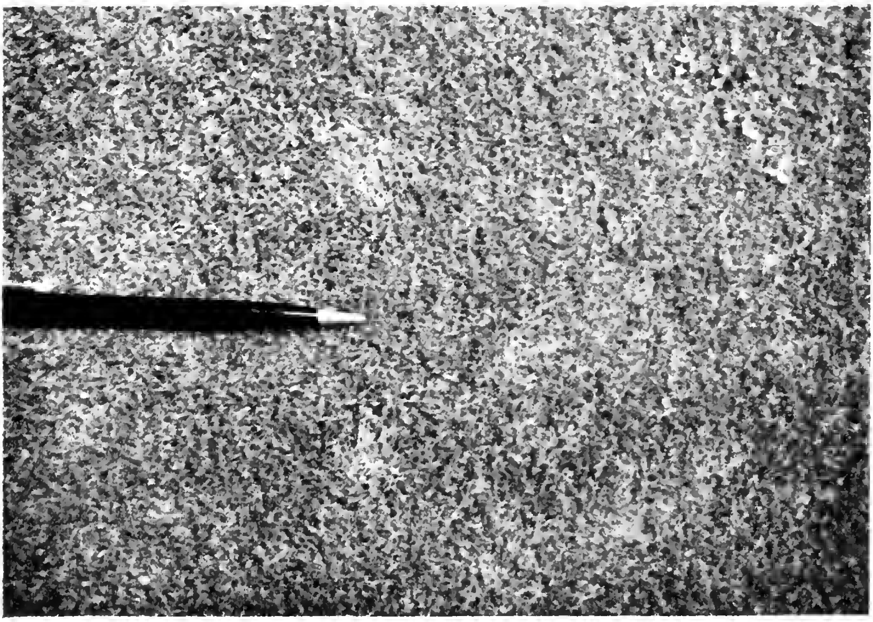




Color plates courtesy Mallinckrodt Chemical Works

Top, Brown patch showing typical smoke ring.
Bottom, Brown patch closeup of wilting at margin.





Photos courtesy University of Rhode Island Experiment Station

Color plates courtesy Mallinckrodt Chemical Works

Top, Mushroom fairy ring of *Marasmius oreades*.
Bottom, Copper spot damage of velvet bent.

A TRIED AND TESTED SCHEDULE

. . . for building and maintaining a successful lawn on poor soil

The following procedures, including yearly spring and autumn feeding, have given a fine lawn for 3 successive years at one site, and 2 years at another. In both cases the soil was hardpan, except for 2 inches or less of poor topsoil. It was almost totally devoid of organic matter, and low in nutrition. Original soil in both plots tested below pH 6.0. The same schedule should be successful on lighter soils in any temperate climate. The cost of building the lawns came to approximately $100.00 per 1000 square feet (exclusive of grading).

Preparation

1. Time: approximately **July 1 to 5.** Original poor turf rototilled in. Depth of tilling, 9 inches; but because of the hardness of the soil, this was done in two successive steps of 4 and 5 inches.

2. Same time. Partially rotted cow manure was applied to the freshly rototilled area at the rate of 2½ cubic yards per 1000 square feet. After spreading the manure as evenly as possible, ground limestone was applied by hand at the rate of 100 pounds per 1000 square feet; 5-10-5 fertilizer was then applied (by hand) on top of the spread manure and ground limestone, at the rate of 100 pounds per 1000 square feet. Sand was also spread at the rate of approximately 1 cubic yard per 1000 square feet. The area with the several different applications of material was then thoroughly rototilled again. It was rolled and allowed to settle. A week after the first rain, spot regrading was done wherever high or low areas were particularly obvious.

3. **July 15 to 20.** Seeded with Japanese buckwheat, at the rate of 2 pounds per 1000 square feet. After sowing and raking, the newly seeded area was rolled lightly.

4. **August 15 to 20.** The vigorous 2½-foot high buckwheat plants were rototilled into the soil while in flower—but before going to seed. After the first going over with the rototiller, 5-10-5 was added at the rate of 75 pounds per 1000 square feet, and rototilled in. The area was then rolled, and allowed to settle over a period of about 2 weeks. Rain helped the soil to become somewhat firm, but not hard. Spot regrading was carried out again, as needed.

5. **September 5 to 10.** Any exposed unrotted debris was raked off, and the ground seeded with Vaughan's mixture of the MERION strain of Kentucky bluegrass (by weight approximately 40% MERION, 40% ILLAHEE fescue, and 20% HIGHLAND bent).

6. **Late September and October.** Germination and early growth of the MERION bluegrass was slow. Chickweed and other fall-growing weeds were removed if they attained any size. The young "turf" was somewhat irregularly established by the end of October, at the time of the first frost. One fall mowing was necessary. The grass remained green throughout the winter.

7. **Mid-April.** The young turf began to grow and fill in rather rapidly. 10-6-4 was applied at the rate of 20 pounds per 1000 square feet, with a spreader. Weeds were removed by hand at intervals of 1 to 2 weeks, for about 3 months. This required an average of about 1 hour every 2 weeks per 1000 square feet of lawn. When growing rapidly, the lawn was mowed twice each week at a height of about 1 inch. Frequent mowing makes short, inconspicuous clippings. Such clippings never need to be raked, yet the lawn always looks neat.

8. **Summer.** The lawn was not watered through the hot months. Growth slowed down perceptibly, and mowing was reduced to once each week or 10 days. It remained fairly green, but with some brownish areas. The summer weeds that appeared in the thick mat of grass were removed by hand, and the few plantain and dandelions were spot-sprayed with 2, 4-D (manufacturer's directions). From mid-

July to mid-August a number of crabgrass plants had become established. Those not removed earlier by hand were sprayed with potassium cyanate (manufacturer's directions) well before they went to seed, and with good success. Some of the dead or dying crabgrass clumps were removed by hand about 2 weeks after spraying, and those remaining (with any show of life) were given a second kill-out spray.

9. **September 10 to 15.** An application of 5-10-5 fertilizer at the rate of 20 pounds per 1000 square feet was made at this time. The mowing schedule was accelerated through autumn as the grass began to grow rapidly again.

On occasion the grass was allowed to become long between mowings, and when this happened the lawn was raked clean. The frequent mowing schedule was best, both as to labor and the neat appearance of the lawn.

After the first summer, frequent hand removal of weeds as rapidly as they appeared (on a few-minutes-a-day basis), kept the lawns weed-free. Occasional dandelions, plantain, and clover were spot-sprayed with 2,4-D in spring, summer, and autumn.

W. H. and G. S. A.

ZOYSIA—AN EVALUATION

In the last few years a great deal of publicity and advertising has been given to two or three different kinds of zoysia, as lawn grasses. The implication in much of this publicity is that zoysias are miracle grasses that will solve many if not all of the lawn problems encountered by the home owner.

A careful look at the facts concerning zoysia as reported by four lawn authorities, shows that much of the advertising is misleading, particularly as it applies to the northern states. This is not through making false claims, but by emphasizing certain advantages possessed by one or another of the zoysia varieties and completely ignoring some of the disadvantages. The following table sums up the highlights.

Advantages	Disadvantages
1. Makes dense, tough, weed-free turf.	1. In the north turns completely brown with killing frost, remains so until spring.
2. Tolerates heat and drought; grows best in summer when northern grasses are more or less dormant and turn brown. Remains resistant to traffic during its growing period.	2. Rather slow-growing, do not expect a fine turf in one season.
3. Grows well during the summer season, the period of greatest use.	3. Expensive—must be started from plugs, not from seed.
4. Can be mowed closely.	4. Brittle and not resistant to "traffic" when dry.
5. Insect and disease resistant.	5. May be somewhat of a fire hazard when dry.
6. Good green color when growing.	6. Not shade tolerant in the North.
7. Shade tolerant *in the South.*	

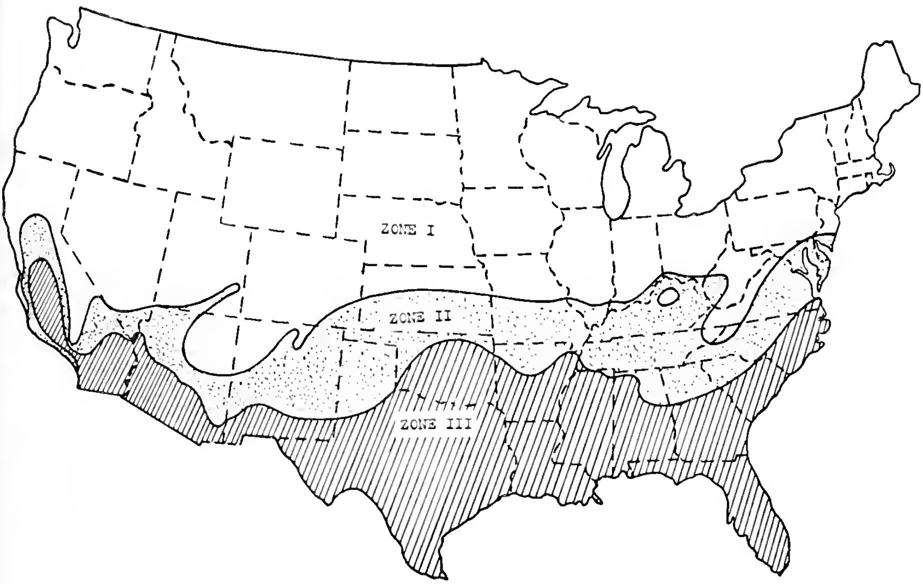
In the South (south of the Ohio River) the advantages of the zoyias outweigh the disadvantages, and they have many splendid qualities for these regions (see page 160), In special situations not too far north they may also be useful, for example, as lawn around a cottage which is used chiefly in the summer.

Trials at the Brooklyn Botanic Garden have shown that zoysia can successfully hold its own against summer lawn weeds and crabgrass, but is occasionally subject to winter killing and is brown generally from about mid-October to May.

For the northern lawn maker who decides zoysias are worth a trial in his particular situation, the presently available varieties most likely to give satisfactory results are Meyer zoysia and the hybrid variety EMERALD.

LAWN CLIMATES

R. W. Schery



Lawn grass zones of the United States.

Schery

I. Zone of general adaptability of cool-season lawn grasses such as bluegrass.

II. Zone where cool-season grasses will survive well with special care (attention to time of fertilizing, high mowing, etc.).

III. Zone where cool-season grasses are best used annually as "winter grass." (In arid country, ability to irrigate is presupposed.)

Latitude has a broad determining influence on growth of grasses. The response of grasses to climate is not so much to some fixed temperature at which a given species will or will not grow, as it is to periods of extreme heat or cold, and to length of growing season. For about each 100 miles one goes northward, spring comes a week later, autumn a week earlier.

Altitude has the same kind of influence as does latitude—each 1000 feet of elevation approximates several hundred miles of northward travel. The Appalachian Mountains afford a significant extension of the "North" into the "South," and northern lawn recommendations hold for the western tips of Virginia, North and South Carolina, and eastern Tennessee. The mountains of the West have a similar influence.

In addition to the broad effects of latitude and elevation, the lawn owner must be mindful of the effects of micro-climates—the local but often great variations found on the average home grounds. A south-facing slope will be degrees hotter in summer and subject to greater temperature changes in winter than will a north-facing one. A breezy location may forestall disease, but may also cause wilting more quickly. In the Upper South the shade of a tree often makes the difference between survival or loss of bluegrass in summer.

Wise handling of these situations as described in various articles in this handbook may spell the difference between success and failure in producing and keeping a fine lawn.

Development of a fine lawn requires careful attention to soil-building as well as planting and maintenance.

BUILDING THE LAWN

The hows and whys of adequate soil preparation

R. B. Alderfer

A LAWN can be no better than the soil in which its roots have to grow. To understand the reasons for the importance of the soil in building a lawn one should know what things grass must get from the soil.

Lawn grasses, like other green plants, depend upon the soil to supply their roots with air, water, and nutrients. A good or poor job of lawn building can be judged on how well these conditions are met.

Grass Roots Need Oxygen

First, consider the matter of air supply: Why is it important and what can one do to insure a properly aerated or well ventilated soil? Like all living things, plant roots must have oxygen. While they do not inhale and exhale—the breathing process of animals—they do absorb oxygen and give off carbon dioxide. This respiratory activity is of top importance because the uptake of nutrients and water by plant roots *is directly controlled* by their rate of respiration. Thus aeration is the key to soil productivity.

Most living things can survive without food for many days and without water for several days, but without sufficient oxygen or with too much carbon dioxide they will die in a matter of minutes. Therefore, plants must have a constant supply of fresh air from the atmosphere flowing to the surface of every living and growing root to replace the stale carbon dioxide-laden air which constantly is building up around these roots. This exchange of air to and from the soil takes

place through the spaces or openings between the solid particles of the soil.

Every soil has two kinds of spaces. The larger spaces between soil particles serve as the air spaces through which a soil "breathes." It is through these large openings that rain or irrigation water runs into the soil and is distributed to the smaller or capillary spaces. These are the spaces in which water is held in the soil.

The Ideal Soil for Turf Grass

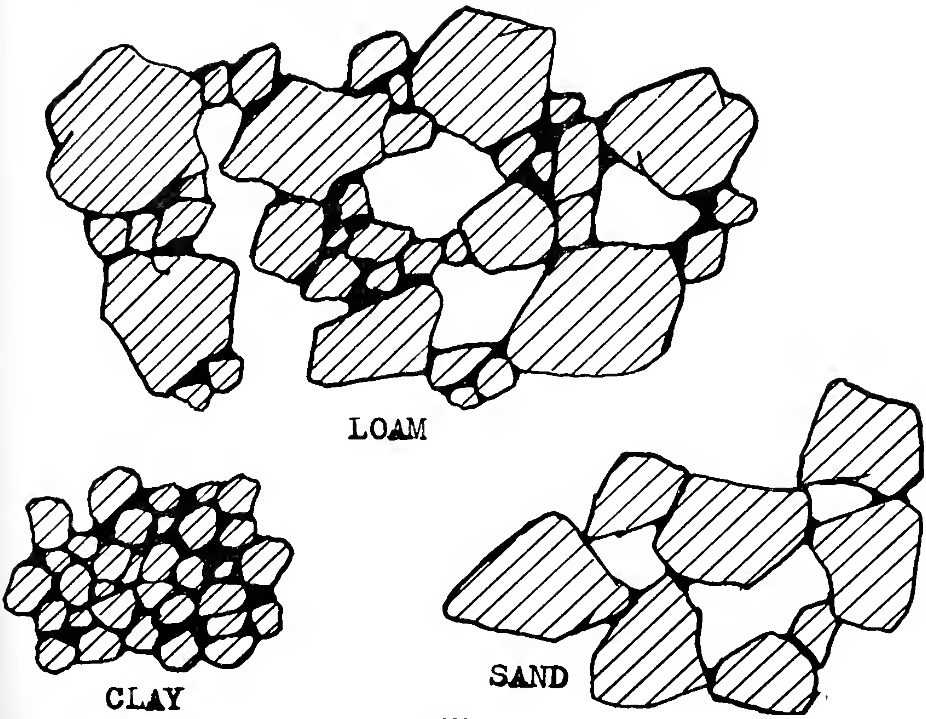
An ideal soil has 50% solid matter, 25% to 30% small pores or water space, and 20% to 25% large pores or air space. Heavy, wet, clay soils often have too little air space, while very sandy soils have too few small water-holding pores.

The size and character of soil pores may be changed by compaction. In building a lawn avoid running heavy machinery over it, especially when the soil is wet. This compacts the soil to the point where the percentage of air space is greatly reduced. In working the soil into condition for seeding avoid reducing it down to a fine powder. At least 50% of the soil can remain in the form of crumbs or granules with diameters of 1/16 to 1/8 of an inch. This will provide enough large openings for good aeration.

Good Drainage is Essential

Adequate drainage is essential for good turf. Poor drainage in a soil is bad because too many of the pores stay filled with water too long. Plant roots will not grow into water-saturated layers. Roots which have grown into soil which is periodically saturated by a fluctuating water table soon die from lack of oxygen due to poor aeration. A poorly drained layer of soil can be detected by its mottled red-yellow-blue and gray color. Wet soil conditions can be caused by poor surface drainage in which water from rainfall or irrigation collects in a low spot on the lawn. This often can be prevented by gently sloping the lawn away from the house, toward a place where water from

Water- and air-holding properties of soil depend upon its texture. (Water, solid black; air, white; solid particles, shaded.)



very heavy rains that the soil cannot absorb will run off safely, such as a paved street, gutter, or woods. Firm, but do not compact, the subgrade as well as the finished surface grade to avoid an uneven surface caused by unequal settling of the soil after the lawn is established.

Presence of a high water table or a flow of seepage water near the surface is a second cause for wet soils. Tile drainage is the best means of intercepting and disposing of water from one of these sources. If such drainage seems to be needed, one should get the advice of a qualified person to help with the design and installation of a tile drainage system. A suitable place to outlet the water from the tile drains is an absolute must.

Wet soils also may be due to the presence of a tight impervious layer in the subsoil. If this layer is thin enough and can be reached it may be ripped with a deep tillage implement and treated with gypsum, 10 pounds per 100 square feet. If the layer is thick and deep the only practical thing to do is to try to provide as favorable conditions as possible in a 6- to 8-inch layer of surface soil.

What is Good Topsoil?

Good quality topsoil has sufficient organic matter in it to give it the tilth, aeration, and water-holding capacity that will make lawn establishment easy. Topsoil quality is to be judged chiefly by its ability to provide good aeration and water-holding capacity but not so much on its fertility. Fertility can be added by proper liming and fertilization. The following specifications for good quality topsoil hold for that which you have on your property or that which you buy.

Texture. Good topsoil should be neither too sandy nor too clayey. It should be loamy in texture. You can identify a loam by taking a handful of moist soil and making a ribbon of it by forcing it out between your thumb and forefinger. If the ribbon breaks off every inch or so after passing your forefinger, the soil is a loam. The ribbon formed by a too sandy soil will break apart right after it leaves your fingers, while a heavy clay will form a ribbon of 3 or more inches before breaking. The texture of topsoil can be determined more accurately by sending it to a soil testing laboratory.

Organic Matter Content. Good quality topsoil should have at least 2% organic matter. While a laboratory test for organic matter is the best, most soils with this percentage of organic matter will be medium to dark brown in color when moist.

Tilth. Good tilth can be determined by seeing how easily the larger lumps break into or can be worked into well-defined crumbs or granules 1/16 to 1/8 inch in diameter. Place a handful of topsoil in a jar filled with water and see how much of it slakes down into a fine mud. No more than 50% of the soil should slake down into particles smaller than 1/16 to 1/8 inch in diameter.

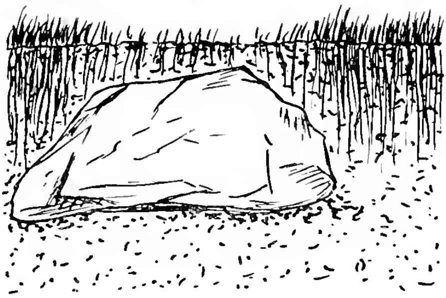
Fertility and Weediness. The fertility and weediness of topsoil often can be estimated by knowing what the land had been used for before you acquired it. If it had been good farm land from which the topsoil had not been removed, one that such a person as your county agricultural agent would vouch for, it will likely be fairly fertile and free of too many perennial weed seeds. Topsoil of the right texture and organic matter content from idle land should not be rejected because of low fertility or weediness. Use of the proper amount of lime, fertilizer, and herbicide will take care of these two problems. The best way to learn the fertility and the acidity or alkalinity of the soil is to have it analyzed by a reputable soil testing laboratory.*

Stock Pile Topsoil

If the land on which the lawn is to be established has a topsoil layer, scrape it off the building area into a pile before digging the foundation. Use the best quality subsoil from the foundation for backfilling around the outside walls and for building up low spots from which the topsoil first has been removed. On land

*See p. 20 of the Spring 1956 issue of Plants & Gardens for list of such laboratories.

McFarland



Shallow soil overlying rocks and boulders too near surface of ground dries out quickly, resulting in death of turf and bare spots in lawn. Rocks should be removed if possible.

that has a large number of stones, boulders, or rock ledges very close to the surface, remove as many of them as possible so as to allow 6 to 8 inches or more of topsoil to remain over them after final grading. Areas with only 2 or 3 inches of soil over a rock layer will never grow good turf.

Waste materials used in building, such as plaster, bricks, boards, etc., should not be buried in the soil, but hauled away.

Improving Poor Quality Soil

The amount of moisture which is available to plant roots that a soil can hold is determined by its texture, aeration and organic matter. A sandy soil generally has sufficient aeration but low water-holding capacity. This is because it has too few small water-holding pores but generally plenty of large air spaces or non-capillary pores. Just the opposite is true for a clay soil. Organic matter is the universal soil conditioning material used to improve the water-holding capacity of sandy soils and the aeration of clay soils. Improving the aeration of clay soils enables plant roots to use the large amount of water which such soils are capable of absorbing and holding. With the proper use of organic matter, land without good surface soil can be made to produce a good lawn.

"Making" Topsoil

Organic matter in the form of cultivated peat, peat moss, well-rotted manure, fine sewage sludge and spent mushroom soil can be applied at the rate of 1 to 2 pounds per square foot or 1 to 3 cubic yards per 1000 square feet. They should be thoroughly mixed with the first 6 or 8 inches of soil. There are a number of other waste materials which can be used as a source of organic matter but a soil or turf grass specialist should be consulted about them.

Buhle

Fine turf in Fragrance Garden at Brooklyn Botanic Garden established by "making" a layer of topsoil (dark upper layer) from poor subsoil with sand, manure, and commercial fertilizer.

Improving Water-holding Capacity

The water-holding capacity of very sandy soils can be increased by applying a 1- to 2-inch layer of clay loam topsoil and mixing it to a depth of 5 or 6 inches. It is more of a task to loosen a heavy clay loam by mixing sand with it. A 6-inch layer of sandy loam topsoil or 3 to 4 inches (1-1½ tons per 100 square feet) of pure sand is required to improve the aeration of a 6-inch layer of heavy clay soil.

Turf grass should have at least a foot of well-aerated soil into which its roots can grow and absorb water. Good turf can be grown with less soil, but moisture problems increase in proportion as depth of soil decreases.

The available supply of nutrients in the soil is regulated by its acidity or alkalinity and the fertility level. The only sure way of learning what these conditions are in a soil is to have it tested. This is particularly important with regard to acidity and alkalinity. Most soils in the eastern United States are naturally acid or tend to become acid if they are not limed regularly. While a test is best, the general recommendation of 50 pounds of hydrated lime or 75 pounds of limestone for each 1000 square feet will adjust the acidity or pH of quite a few soils to near the desired level. All liming materials should be thoroughly mixed with the soil to a depth of 6 or 8 inches as long before fertilization as possible.

Fertilization Is a Part of Lawn Building

The best time to establish a high level of fertility in the soil is when the lawn is being built. The necessary nutrient materials can be mixed to a greater depth at this time than at any other. The opportunity to get liberal amounts of nutrients like phosphate and potash into the soil most efficiently at this time should not be neglected by the lawn builder. (For kinds of fertilizers to use and rates of application, see p. 93.)

Good soil preparation that will provide adequate aeration, insure optimum moisture supply, and furnish sufficient nutrients to maintain vigorous growth of the grass is the base on which good lawn building must be laid. Disregard for any of these basic factors can result only in disappointment and wasted effort.

MAKING A LAWN

—a pictorial guide

Ground around new homes is often stripped of top soil, and the remaining subsoil is badly compacted by heavy machinery. Soil must be rebuilt before a lawn can be successfully established.

Photos courtesy Scott's

Garden plough is useful in breaking up compacted soil and working in organic material and fertilizer—and lime if needed.

Discing helps to further prepare the soil.

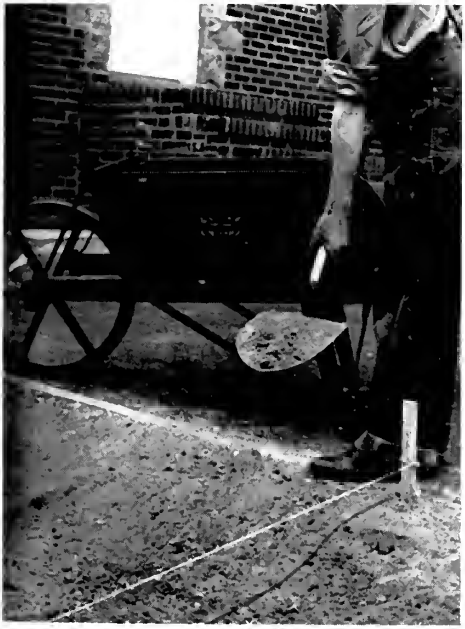
Scott's

I[illegible] is not large, or if plough and disc are not available, ground can be prepared [illegible] spading. Organic material, etc., should be worked in during spading.

Scott's

Next st[illegible]p is to rake out stones or other debris.

Rolling with light roller firms ground, reveals low spots.



Ground is levelled by filling in low spots, and rolling lightly.

Roche pho

Fertilizer is applied, and lime if needed. Careful use of spreaders insures even distribution (see page 92).

Seed is sown at rates recommended in table below. If sown by hand, a jar with perforated top helps even distribution.

Roche photos

Seed can be distributed more evenly if applied with a spreader. CAUTION: To prevent heaping up of seed (or fertilizer) at ends of rows, turn on spreader just after starting, and turn off just before stopping.

Rates of Sowing

Mixture	Rate per 1000 sq. ft.
Predominantly Fescue (80%) with Bent (20%)	5 lbs.
Fescue (60%) Bluegrass (30%) Bent (10%)	6 to 7 lbs.
Predominantly Bluegrass (70%) Bent (30%)	3 to 4 lbs.

After sowing, seed is covered by very light raking.

Scott's

Roche

Seed can also be covered by dragging newly planted soil with steel mat. This method is good for large areas.

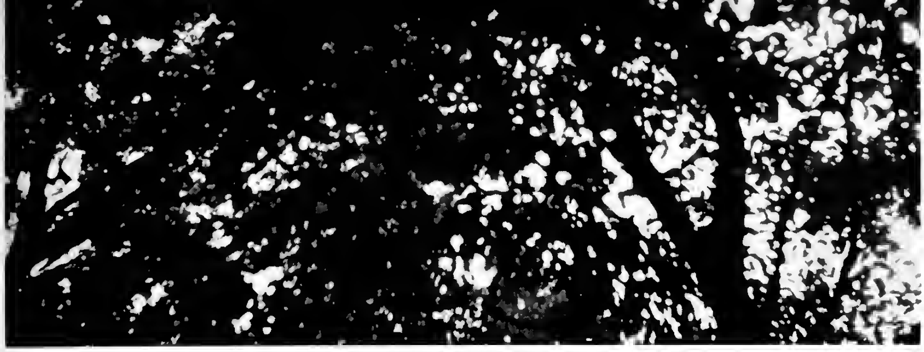
Planted area is thoroughly but *gently* watered.

Roche

Covering newly seeded area with a light straw mulch is an excellent, but not essential practice (also see page 151)

After mulch is applied, water thoroughly. Mulch helps hold seed in place and conserves moisture; should be carefully and lightly raked off as grass comes up.

Schery photos



Grau

Little light can filter through dense canopy of leaves, creating problems for lawnmakers.

CARE OF LAWNS IN SHADE AND ON STEEP SLOPES

Proper grasses to use and how to maintain them in difficult locations

Ralph E. Engel

GRASS failures are frequent in shade and on steep slopes. They are the most common disfigurations of otherwise attractive lawns. Many of these situations could be improved with some additional care or attention to special needs. Most people consider themselves fortunate to have some shade, and steep slopes are frequently unavoidable. But, to have an attractive lawn under these circumstances demands that certain problems get special attention. All lawns have certain requirements for moisture, nutrients, light, and air. Basically the problems with shade and slopes are largely an intensification of certain of these lawn requirements. Shaded and steeply sloping areas generally suffer from lack of nutrients and soil moisture. Deficiency of sunlight is an added factor in shaded areas. Fortunately, there are methods which enable us to grow a grass or other plant cover on most shaded or sloping areas.

Growing the Shaded Lawn

Shade is most serious under such trees as evergreens, and Norway maple and beech. The evergreens cast shade all year; the Norway maple is well-known for its heavy surface rooting as well as for its dense shade. Elms, oaks, and sycamores produce more moderate shade and offer a better chance for growing a satisfactory turf. The difficulties vary even with trees of the same species, depending upon the density of stand and the distance of the branches above the ground.

Buildings may add to the shade problem. While they do not rob the grass of nutrients and water, they prevent air circulation and increase the difficulties where dampness is a problem.

One of the first things to do in dealing with a shady lawn is to estimate how serious the problem is. If the shading is extreme, it may be necessary to eliminate some of the shade or to select some planting other than grass. English ivy (*Hedera helix*), pachysandra (*Pachysandra terminalis*), and "myrtle" (*Vinca minor*) are satisfactory for any but severe climates. Some of the more extreme shade problems may be overcome by judicious pruning of the trees or removal of poor and surplus trees.

The turf grasses differ greatly in their shade tolerance. Red fescues (certified

Courtesy Scott's

A luxuriant lawn in shade is not easily achieved, but shade-tolerant grasses, properly cared for, make it possible (see text).

creeping, Chewings, ILLAHEE, and PENN-LAWN), and rough-stalked bluegrass are the commonly used shade-tolerant grasses of the humid northern regions. The red fescues prefer a well-drained soil, while rough-stalked bluegrass will tolerate wet, shaded locations. Velvet bentgrass is a good shade grass in cool humid climates, but seed of this species is scarce. Among the cool-season grasses, Kentucky bluegrass and Colonial bentgrass do not tolerate dense shade; among the warm-season grasses, Bermuda grass is very intolerant of shade.

Grass failure in shade may result from a lack of nutrients and moisture when trees are present. If the shade is very intense, the grass may be weakened or fail because of insufficient sunlight. Shade is a more acute problem in cloudy regions.

Establishment of Grass in the Shade

Seedbed preparation and seeding practices for shady areas are essentially the same as for the rest of the lawn (see page 139). The only extra precaution that should be taken is to practice late summer or early fall seeding almost exclusively. Wherever deciduous trees (trees that shed their leaves) are present planting at these times will give the maximum time for the grasses to become established before the leaves return. On occasion, seed can be spread in the winter. This may still give the grasses a sufficiently early start to become established before the trees leaf out in the spring. Use care to keep fallen leaves off new seedings as this reduces sunlight and it leads to smothering of the seedling grasses.

Sod may be used to establish a turf in shade. However, care must be taken to prepare the soil correctly and to obtain turf of shade-tolerant grasses. If these points are overlooked, there will be no benefit from direct sodding.

Care of Shady Lawn Areas

Fertilize the lawn adequately. On cool-season grass lawns, two applications of complete fertilizer per year at a rate that will supply 2 pounds of nitrogen pe

1000 square feet per application (10 pounds of a 10% nitrogen fertilizer or 20 pounds of a 5% nitrogen fertilizer) is considered near the minimum for maintaining a dense attractive lawn. Additional applications are frequently required for the shaded lawn. Even though some of the fertilization carries into the hot weather period, this is not likely to prove troublesome on the shaded lawn because crabgrass is no problem.

Deep feeding of trees has been used as a means of encouraging deeper tree root development, leaving more nutrients and water at the surface for the grasses. This is done by driving holes into the soil to a depth of 2 or 3 feet and pouring fertilizer into these openings. If the trees have already developed an abundance of surface roots this procedure may be less beneficial. Also, some kinds of trees may persist in their shallow-rooting habits in spite of such measures.

Watering

Use care in watering the shady lawn. Excessive watering and slow drying can lead to serious disease problems. Water only in dry periods when the grass starts to suffer; delaying until the grass is partially dead should be avoided. Apply the water very slowly over a long period of time to provide deep penetration.

Avoid close mowing of shaded lawn areas. The maximum amount of leaf area is required for food manufacture. A cutting height of $1\frac{1}{2}$ to $2\frac{1}{2}$ inches is recommended. Do not allow large amounts of clippings to remain on the shaded lawn. This prevents the much needed light from reaching the grass.

Considerable amounts of debris such as twigs and leaves may collect on the lawn under trees. These should be removed by gently raking. Use care to avoid injuring the grass plants which are weak and often poorly rooted.

Growing a Lawn on a Slope

The growing of lawns on slopes is difficult because materials applied to the surface are often washed away. If fertilizer, lime, water, and other materials fail to penetrate the soil in appreciable quantity, the turf suffers. On slopes with southern exposure high temperatures may destroy the turf. Other factors may add trouble for the grass—for example, steep slopes are often damaged by mower wheels which tend to slide on the slope.

Care of the Lawn on Slopes

Since fertilizer has a tendency to wash off the slopes, applications should be lighter and more frequent than on level lawns. This will aid in growing a turf cover of greater density. Possibly two or three extra applications could be made per year during the cooler growing periods of early spring or fall.

Slopes with a southern exposure are the first to require water in hot, dry weather. Do not delay until the grass is dead. Water very slowly to avoid run-off, and permit penetration into the soil.

Grau

Heavily shaded slope in Georgia has been strip sodded with *Zoysia matrella*. Success under these conditions is rare.

Aerating lawns aids water penetration and reduces run-off, which is severe on slopes like this.

Grau

If the cover is thin and the soil is very hard, some spiking of the slope will reduce the washing of fertilizer and other materials off the slope. A number of machines are available in different styles and sizes which should help overcome this problem or, if the slope areas are not large, it can be done by hand (see illustration).

In mowing use a high cut on slopes where such species as Kentucky bluegrass and red fescue are grown. This will reduce run-off and insulate the soil against water loss and heat. Except for MERION blue, these grasses will tolerate a meadow-like condition with only two or three mowings a year. Some people find the high, infrequent mowing method quite satisfactory for such areas.

The problem of slopes can always be dealt with directly. Some slopes can be made more gradual. Retaining walls can be used to create two levels. As far as possible avoid high walls; lower ones are less dangerous and they can be a beautiful part of the landscape. Some very steep slopes may always prove troublesome for grass. Where this is the case a ground cover such as ivy or periwinkle (myrtle) may prove more satisfactory. However, it is often surprising what unlikely sites will grow a good grass cover provided man does not persist in making conditions more severe.

McFarland

In some heavily shaded situations it is advisable to use a ground cover other than grass. Myrtle or periwinkle (*Vinca minor*) is good. If even such plants fail, flagstone may be the only answer.

REPAIRING POOR LAWNS

With a little effort and know-how, unsightly bare spots in the lawn can be renovated

W. H. Daniel

WHEN a lawn fails the first question that needs an answer is "Why did it happen?"

A common experience is to have certain large trees shade out the lawn beneath—or rob it of nutrients and soil water. Excessive wear from too-continued walking in a certain place (a path, for example) is another common reason for having to repair small areas. There are limits to what any turf will stand. These vary, depending upon the way in which it is treated.

Plant "adapted grasses" is a basic rule. Grasses not adapted to the climate and soil fail even with good care, so proper grass selection is essential.

A rule of thumb is, "Lawn grasses will withstand abuse in use, but not abuse in care." One muddy football game may spoil the green look of a field with a bluegrass turf, but the rhizomes should quickly put out new leaves. However, if the cutting was too low for the leaves to produce sufficient carbohydrates for rhizome development, then little regrowth can be expected even without muddy games. So a second basic rule is to cut the grass high enough to provide sufficient leaf area.*

Other steps necessary to attain maximum resistance to wear include adequate fertilization to insure continuous growth, proper watering, and keeping the soil sufficiently loose and open to provide good air and moisture supply. Even when all these things are done properly, sometimes excessive wear or accident will require special renovating operations to restore good turf quality.

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*The "mow high" slogan does not apply to MERION bluegrass or to the bentgrasses (see p. 168).—Ed.

Scott's

An edging tool is useful in cutting and loosening soil for spot repairing of lawn.

First step in spot sodding: fill spot with fertile soil. Make space for new sod by removing old soil and partly replacing it with fertile new soil.

Square of good sod is cut from inconspicuou part of lawn or "sod nursery" with edgin tool.

Improvement by Spot Sodding

Sometimes on important areas as a home lawn, beside a front walk, or near a sidewalk, bare patches develop and improvement is needed. In many cases the best and simplest way of repairing these is by resodding. Quite often it is possible during the fall or early spring periods to go to the edge of the flower garden, shrub beds, or other border areas and take small chunks of sod which can be set into the bare areas with a minimum of effort. Since this sod is already growing and does not need to germinate and establish itself, its chances of surviving in these difficult areas are much better than are those of a few seeds promiscuously spread with an idea that "seed will cure the ill." If the amount of sod removed from a back lawn, or a less important area along the edge of a bed is large, this out-of-the way area can be reseeded and very soon reestablished to conform to the rest of the lawn.

The use of small pieces of sod set int bare areas on banks where erosion is problem is doubly advantageous. Usin such small pieces in early spring, there i a minimum need for carefulness, yet ero sion can be controlled and the law smoothed for maintenance during th summer. When available, sod plugger often work more satisfactorily for suc operations than shovels do (see p. 171

Spot Renovation by Seeding

Many home owners annually oversee the entire lawn area, as a step in over-a renovation. This is seldom necessary an usually results in a maximum waste o seed with minimum improvement. It much better to concentrate on the thi and bare spots, following a few simp rules.

Reseeding is most successful when it done early in the spring or in the ear autumn, so the seed can germinate ar

Sod is removed carefully to avoid breaking.

Place square of sod in previously readied spot to be repaired.

Tamp sod firmly into place, then water area thoroughly. *McFarland pho*

be ready to grow during cool moist weather. Accepted procedures include application of fertilizer and lime if needed, spreading the desired lawn grass seed mixture, and shallow raking to remove dead grass and weeds without damaging the existing turfgrass plants. If done conscientiously these may contribute to improved stands with a minimum investment in time and cost.

Using Mulch

When it is necessary to seed bare areas, the use of some type of mulch is recommended. Of the several materials available—peat, straw, sacking, or pea gravel—each has its advantages and often it is a matter of supply or past experience which dictates whether one of these or no mulch at all will be used. For small areas fine pea gravel ($1/4$ inch or less) serves to reduce surface erosion, yet keeps the seed below in place and moist.

Renovating by seeding. Fertilizer is applied, and lime if needed.

Rake area thoroughly to remove dead grass and weeds, and loosen soil; this also mixes fertilizer with soil.

McFarland photos

Sow seed by hand or spreader (see page 142).

After sowing, rake lightly to cover seed.

Courtesy Scott's

McFarland

Roll lightly to compact soil around seed.

McFarland

Water gently and thoroughly, and cover with sacking or straw. Remove cover as grass comes up.

For larger areas straw mulches are excellent. Straw usually stays in place rather well if kept moist and if the edges are stabilized against driving winds.

The home owner may use various kinds of sacking if it is understood that the purpose of the sacks is to keep the seed underneath moist until it germinates. The sacks should then be removed so the seedlings get maximum sunlight. Too often they remain on indefinitely with the result that in areas where the best germination occurs, poor survival of seedlings results because of shading and excess moisture under the sack.

Lawn Repair Under Trees

A common problem of the home owner is bare lawn areas under shade trees. Many home grounds with beautiful trees have thin turf under them, or no grass at all. Growing two crops, trees and turf, requires special care and practices. The idea is to supply both with nutrients and moisture so that each can thrive and contribute to the lawn.

Can a satisfactory turf be produced under such conditions? Certainly, if one knows how and is willing to make the effort.

1. Under a good-sized tree, put on a bale or more of peat, out to 5 feet beyond the spread of the tree. (When worked into the soil, peat retains extra moisture and nutrients, increases the soaking in of water, and softens the ground.)

2. Spread 25 pounds of a complete fertilizer (for example, 10-8-6 or 6-10-4) on top of the peat. If tests show the soil to be too acid, add ground limestone as recommended (p. 97).

3. With your back toward the tree, spade and mix in the above materials as deeply as possible, using a well-sharpened shovel. This will destroy the tree's small surface feeder roots which rob the turf of water and nutrients. Large tree roots have lost their ability to absorb moisture and fertilizer, so let them alone. The tree will put out new feeder roots, and it already has many deeper ones. Meanwhile, the grass will have a chance to get established with less tree root competition.

4. After spading, level the ground and spread 5 pounds more of fertilizer and 1 pound of grass seed over the whole area. (Many companies prepare shade grass mixtures which contain MERION bluegrass, rough-stalked bluegrass, creeping red fescue, redtop, and Colonial bentgrass.)

5. Rake lightly. Any peat that works to the surface will act as a mulch. If desired, a thin layer of pea gravel about ¼ inch deep will hold the seed in place and cut down evaporation.

6. Dampen the new seeding every other day in dry weather until the seedlings are 1½ inches high.

Pointers to Remember in Repairing Lawns Under Trees

Seed in Fall. It is easier to establish a dense turf under trees by seeding in the fall. As leaves drop from the trees more light gets to the grass. Keep fallen leaves removed from newly-seeded areas!

Use Shade-tolerant Grasses. MERION bluegrass is resistant to leafspot, so is especially good under trees in the Midwest and many other areas. If tree-shaded areas are naturally damp, plant rough-stalked bluegrass; if dry, use Chewings red fescue, particularly under coniferous trees.

Aerify the Soil. In routine maintenance after new grass is established, it is good to aerify and if dry to water adequately. A hand aerifier is on the market that will, with about a half-hour's work, completely aerify the area under one tree. The common spading fork can be used as a substitute for the hand aerifier for punching holes in sod.

Spread fertilizer as first step in repairing lawn under tree. If soil is compacted apply peat moss before putting on fertilizer (see text).

Spade with sharp shovel to incorporate peat and fertilizer into soil, also to destroy shallow feeding roots of trees.

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After spading, level the ground, add more fertilizer, and sow seed evenly on prepared surface. Rake in lightly.

Berggren photos

Water gently. A thin layer of pea gravel holds seeds in place and keeps soil moist during germination.

LAWN GRASSES FOR THE SOUTH

How to establish and maintain a fine lawn in a warm climate

Glenn W. Burton

FOR years, a barren yard swept clean of all vegetation was considered evidence of "good housekeeping" in the South. Certainly, it was to be preferred to the weeds that would have taken over in the absence of good turf grasses and mowers to keep them cut. Today such yards are hard to find—thanks to improved lawn grasses, more know-how on their culture, and better equipment for their maintenance. Everywhere people are recognizing that a good lawn helps to make a house a home. Good lawns are basic in any landscaping program. They bring satisfaction and relaxation to the family and increase the material value of the home. Without grass, parks lose their appeal and cemeteries become drab indeed.

Most people in the South are looking for a lawn grass that will stay green the year around. Unfortunately, those grasses that grow well during the summer turn brown after the first freeze and stay brown most of the winter. In most of the South, the grasses that remain green during the winter become dormant, turn brown, and usually die during the summer. Thus, except for those limited areas protected from frost, two different species are needed if one wants a green lawn around the entire year. Domestic (annual) ryegrass is generally the best species for a green lawn in winter, but since it dies out in the summer, it must be planted each fall. If a green lawn is desired for winter, broadcast ryegrass seed evenly in the fall and work it down in contact with the soil. Then water to hasten germination, fertilize freely, and mow regularly for best results.

Shaded area shows regions to which this article applies.

All Turf Grasses Must be Mowed

A very frequent request from new home owners is for a lawn grass that requires no mowing. Although some grasses require less than others, none will make a satisfactory turf without some mowing. There are a number of good lawn grasses from which one may choose. Unfortunately, none of them are perfect. For best success, choose a grass that fits the environment in which it must be planted. The information included in the accompanying table will be helpful. Carpet grass (*Axonopus affinis*), for example, will winterkill in Kentucky, whereas Kentucky bluegrass (*Poa pratensis*) will usually not survive the long, hot summers experienced in the carpet grass belt. If one's soil is poorly drained, carpet grass will do better than Bermuda grass (*Cynodon dactylon*) unless one is willing to go to the extra expense of putting in drain tile. Bermuda would be a poor choice for use under shade trees.

By changing the environment, one can grow species that otherwise could not be successfully grown. For example, Bermuda grass will make excellent turf on the poorest sands when they are heavily fertilized, and carpet grass will grow in dry sites if it can be watered frequently. Removing or trimming up trees permits growth of the less shade-tolerant grasses, if one has a preference for them.

If you are a busy home owner who must neglect his lawn, you will do well to choose a grass that makes a satisfactory turf with a minimum of mowing and care. Centipede grass (*Eremochloa ophiuroides*) is a good choice. It should not be planted on farm lawns, however, because it may get into pastures and destroy their grazing value.

Common Bermuda grass, most drought resistant of southern lawn grasses.

Bermuda Grass Most Drought Resistant

Here are some additional pointers on available lawn grasses that should help you to choose the best grass for your needs. Bermuda grass will stand more drought than any of the other species listed here. Few grasses will tolerate as much wear as Bermuda, and as a grass to grow in association with ryegrass for year-around lawns, it is unsurpassed. TIFLAWN and TIFFINE make a greener, denser, more beautiful turf than common Bermuda and recover much faster when overseeded with ryegrass. Although they must be established from sprigs, their rate of spread permits wide spacing and keeps establishment costs low. TIFLAWN (TIFTON 57) is splendid for football fields, playgrounds, etc. where the turf receives a great deal of hard wear. TIFFINE is lighter-green in color, makes a finer looking turf because of its narrower leaves, and is better for the fine Bermuda lawn that receives only moderate wear. Both grasses are resistant to disease and to most turf insects except army worms. Even when not controlled, army worms inflict only temporary damage, defoliating the grass for but a very few days each year. Since delayed mowing leaves Bermuda lawns looking brown for several days, they should be mowed regularly and frequently for best appearance. If you have a flower border around the lawn, particularly annuals, remember that Bermuda grass is a greater pest in flower beds than any of the other species mentioned here.

Author photos

Centipede grass lawn.

PRINCIPAL LAWN GRASSES

Kind	Region Where Adapted	Shade Tolerance	Sc Fert Requi
Bermuda grass	Throughout South	Poor	Hi
Tiffine Bermuda	Throughout South	Poor	M
Tiflawn Bermuda	Throughout South	Poor	M
Carpet grass	South of Augusta, Ga. and Birmingham, Ala.	Medium	L
Centipede grass	South of Tennessee	Medium	L
Domestic ryegrass (fall-seeded for winter lawns)	Throughout South	Very good	H
Kentucky bluegrass	Tennessee north; in shade, south as far as Birmingham, Ala.	Good	H
St. Augustine grass	South of Augusta, Ga. and Birmingham, Ala.	Very good	H
Zoysia japonica	Throughout South	Very good	H
Meyer Zoysia	Throughout South	Very good	H
Zoysia matrella	Throughout South	Very good	H
Emerald Zoysia	Throughout South	Very good	H

Centipede grass is coarse in texture, much like common Bermuda grass and St. Augustine.

Carpet and Centipede Grasses Need Acid Soils

Carpet grass seed is usually inexpensive, making its cost of establishment very low. In low, wet areas, it will make a reasonably good turf at very little cost. It is resistant to most insects and diseases and requires little expenditure for fertilizer. It grows best on acid soils and becomes chlorotic (due to iron deficiency) and dies on neutral or alkaline soils. Never lime the soil in which you intend to plant carpet grass. Carpet grass produces long, slender seed stalks most of the summer. These heads give the lawn a ragged appearance whenever mowing is delayed. Reel-type lawn mowers will not cut carpet grass clean unless it is mowed

l Preference	Propagation Method	Period When Green	Care Required
drained lium-heavy	Seed (2 lb./1,000 sq. ft.) or sprigs	Spring, summer, fall	Medium to much
drained lium-heavy	Sprigs	Spring, summer, fall	Medium to much
drained lium-heavy	Sprigs	Spring, summer, fall	Medium to much
sandy	Seed (2 lb./1,000 sq. ft.) or sprigs	Spring, summer, fall	Little
preference	Sprigs or seed (4 oz./1,000 sq. ft.)	Spring, summer, fall	Very little
drained ivy	Seed (4 lb./1,000 sq. ft.)	Winter	Much
drained	Seed (3 lb./1,000 sq. ft.)	Varies with region	Medium to much
y loam	Sprigs	Spring, summer, fall	Much
drained ivy	Sprigs or seed (8-16 oz. hulled seed/1,000 sq. ft.)	Spring, summer, fall	Medium to much
drained ivy	Sprigs	Spring, summer, fall	Medium to much
drained ivy	Sprigs	Spring, summer, fall	Medium to much
drained ivy	Sprigs	Spring, summer, fall	Medium to much

frequently enough to remove the heads before they reach their full height.

Centipede grass is highly resistant to chinch bugs, army worms, and most of the insects and diseases that attack lawn grasses. It is quite susceptible, however, to a comparatively new soil-borne insect commonly called "ground pearl." The ground pearl is a tiny, spherical insect about the size of a pinhead that feeds on the grass roots through a long, hair-like mouth part. It is yellow or pearl-colored and is covered with a waxy coating that protects it from most insecticides. This insect causes the grass to wilt and often to die during dry periods. Fertilization and watering are the only practical control measures now available. Centipede

TIFFINE variety of Bermuda grass makes a fine, dense turf.

Author photos

Short seed stalks of centipede grass.

grass is subject to iron deficiency when over-fertilized, over-watered, or limed. Spraying with copperas (iron sulfate) at the rate of 2 ounces per 1000 square feet or applying it dry in the fertilizer will usually correct this deficiency. If not controlled, the grass may die out completely. (See PLANTS & GARDENS, Winter 1954, p. 258.) Centipede grass makes a dense turf that chokes out weeds. It is easy to mow even when mowing has been delayed for several weeks. If sprigs are to be planted, be sure to check the soil from which they were dug, making sure there are no ground pearls in it. The hazard of introducing ground pearls into the lawn with the planting stock can be avoided by planting seed. If you plant seed, remember to water frequently while the plants are small. They will tolerate little drought during early development.

Good Shade Grasses

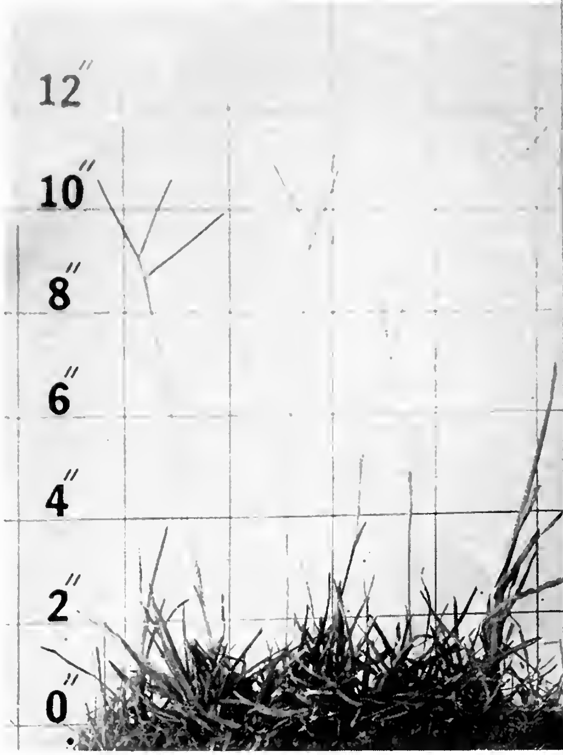
St. Augustine grass (*Stenotaphrum secundatum*) has long been popular for shaded lawns in the Deep South. Unfortunately, it is susceptible to several diseases that damage it severely during prolonged rainy periods. It is also very susceptible to chinch bug, a tiny, sucking insect that attacks the leaves and stems. Many St. Augustine grass lawns have been killed by this insect, particularly in the unshaded areas where the insect prefers to work. DDT, dusted or sprayed on the leaves, usually gives good control. Investigate all wilted areas for chinch bug, and dust the grass while the bugs are small and few in number. Delayed treatment may come too late to save the grass. St. Augustine does best on neutral or slightly alkaline soils. Most southern soils need some lime. Have your soil tested for lime requirement to avoid over-liming.

The Zoysia Grasses

The zoysia (*Zoysia* spp.) grasses make excellent turf when established and managed properly. They are resistant to most insects and diseases and once established, make a very dense, weed-free turf. They have a desirable dark green color and are tough enough to withstand fairly heavy foot traffic. They are highly shade-tolerant. Since they are more frost-tolerant than the other summer-growing grasses, they often remain green longer in the fall. They do turn brown in the winter, however, and make such a dense turf that it

s next to impossible to grow winter grasses, like ryegrass, with them. The zoysias spread very slowly, making them costly to establish. They are more susceptible to drought injury than Bermuda grass, so require more watering during dry periods. They are tough and difficult to mow, particularly when mowing is delayed. When improperly managed, they (*Zoysia matrella* spp., particularly) build up a tough, dense mat that is difficult to dispose of. MEYER zoysia makes a better turf than ordinary *Zoysia japonica*, but both are coarse and, in most of the South, are generally inferior to the narrower-leaved *Z. matrella*. EMERALD zoysia is a "*matrella*-like" hybrid that is superior to the *Zoysia matrella* selections with which it has been compared. Zoysia sprigs should be planted 6 inches apart in 6-inch rows for reasonably quick coverage (usually several months are required).

Planting stock of the vegetatively propagated grasses described above can be purchased from a number of nurseries in the South. Improved varieties such as TIFLAWN, TIFFINE, and EMERALD are being certified for the protection of the purchaser. Buying certified sprigs is one's best guarantee.



Author photos

Tall seed stalks of carpet grass are difficult to cut with a reel mower.

Culture and Care

Remember, the best grass in the world will fail without proper care. Most southern soils require 5 to 10 pounds of a good complete fertilizer, such as an 8-8-8, per 1000 square feet early every spring. One or more applications of a nitrogen fertilizer such as ammonium nitrate (1 to 2 pounds per 1000 square feet), Milorganite, or cottonseed meal (5 to 10 pounds per 1000 square feet) made during the summer will improve the color, thicken the stand, and help crowd out weeds. Apply fertilizer evenly when the grass is dry and water it in to prevent burning.

Regular and frequent mowing increases sod density, discourages weeds, and makes any lawn grass more beautiful. Southern turf grasses, with the exception of bluegrass, should be mowed at a height of approximately 1 inch. Mow frequently enough that clippings can be allowed to fall without smothering the grass. Every 7 to 10 days is best in mid-summer when growing conditions are optimum.

Water thoroughly when evidence of wilting is apparent. Check the amount of water the sprinkler puts out by placing an empty can in the area being watered. Don't move the sprinkler until there's at least ½ inch of water in the can. Don't water again until the grass shows evidence of wilting.

Chlordane will control sod webworm and many other turf insects. Toxaphene is more effective as an army worm control.

If your lawn begins to show unexplainable signs of dying, consult your county agent. He can supply or obtain the assistance you need. Remember: a good lawn, like good health, is easier to keep than to recover, once lost.

MOWERS AND OTHER LAWN MAINTENANCE MACHINERY

. . . pointers, even for those who know

J. R. Watson, Jr.

MACHINERY and equipment required for proper lawn maintenance should be selected on the basis of the size and layout of the area, as well as the proportion of the maintenance requirements to be handled by the home owner and what, if any, by a professional lawnkeeping service. Assuming the entire maintenance will be handled by the home owner, certain basic units are needed. These are: a mower, fertilizer spreader (which may double as a seeder when necessary), aerator, irrigation equipment, and certain more specialized items, such as edger-trimmer, sprayer, sweeper, cart or wheelbarrow, roller; also such basic hand tools as hoe, rake, shovel, and trowel. With these tools on hand, most of which will last indefinitely if cared for properly, the home owner will find any phase of work connected with lawn care and maintenance easy, quick, efficient, and rewarding.

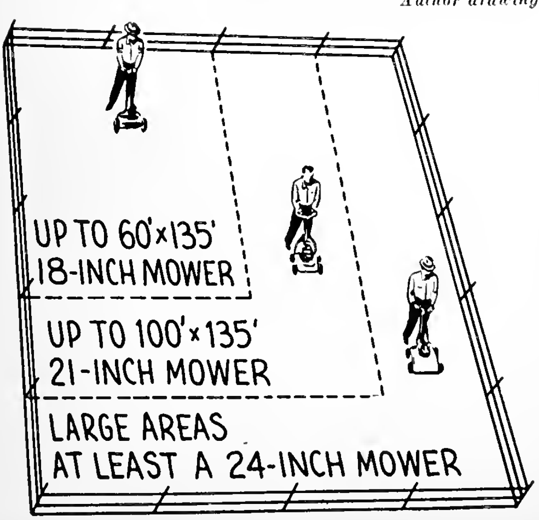
Mowers

Grass cutting is undoubtedly the most time-consuming part of the lawn maintenance program. Also, good mowing practices are perhaps the most importan[t] single factor contributing to the well-groomed appearance so desirable in a lawn. For these reasons the selection and care of the mower are particularly significant.

Selecting the Mower. Mowers are available in varying widths and with numerous features. Requirements of a goo[d] mower are maneuverability, easy adjustment, durability, sturdiness, and adequat[e] horsepower for the size of the mower an[d] the usage expected. In addition, the ready availability of parts and service is a[n] important consideration when choosing the mower.

The width of the mower chosen will b[e] determined by the size and layout of th[e] lawn area. The diagram shows the widt[h] of mower needed for efficient cutting o[f] lawns of various sizes. The diagram doe[s] not take into account terraces, trees, shrubs, flower beds, etc., which may b[e] present. Large open expanses have requirements entirely different from thos[e] of small broken-up areas.

Recommended width of mowers for lawns of varying sizes.
Author drawing



Reel vs. Rotary Mowers

Two basic types of mowers are avail[able]—the **reel** and the **rotary.** Choice wil[l] be governed by the particular duties ex[pected] from the mower. Each type ha[s] certain advantages and certain limitation[s] which need to be carefully considere[d] when the selection is made.

Reel-type mowers are always recom[mended] for the cutting of formal an[d] semi-formal lawns. The cutting action o[f] the reel is like that of a pair of scissor[s]. Reels, when sharp, properly adjusted, an[d] in good operating condition, give a clea[n] even cut and leave the lawn with [a] smooth, well-groomed appearance.

Practically all reel-type power law[n]

mowers are self-propelled. Other desirable features to look for in reel mowers are:

1. Handles that can be easily adjusted for height to suit the individual operator.
2. Handles which stand up or fold up for easy storage.
3. A range of cutting height adjustment from ½ to 2 inches.
4. Large sectional rollers — these improve handling qualities and reduce damage to good turf.
5. Safety guards over chains and other moving parts.

For bentgrass and fine-leaved Bermuda lawns, the reel should have at least six, preferably more, blades. This gives a closer frequency of clip (the distance between cuts as the mower progresses) which eliminates a riffled or corrugated appearance of the lawn.

Rotary mowers are more adaptable to rough conditions and to areas where control of grass, rather than appearance, is the main consideration. In addition to controlling the grass, they may also be used to (1) pulverize or grind up leaves, thus returning valuable organic matter to the soil; (2) cut tall-stemmed weeds, tall grass, and other unruly vegetation; and (3) small rotaries often may be used for trimming.

The rotary cuts by "impact" similar to the cutting action of a scythe. For this reason, a sharp, properly balanced blade is necessary to avoid a ragged tearing of the grass blade. Cutting with a dull blade generally results in a graying and subsequent browning of the leaf tip. An occasional touching up of the cutting portion of the blade with a hand file will help reduce this condition.

Self-propelled power mower. Large rollers make for ease of handling, reduce damage to turf.

Roche

In mowing near cultivated areas such as flower beds, keep both wheels on grass and leave narrow uncut strip. Cut this strip with one-wheeled mower (see page 167). If latter is not available cut with regular hand mower, by short back and forth pushes straight toward bed. This saves edge of lawn and reduces need for hand clipping.

Scott's

Rotary mower in action, best used in rough areas (see preceding page).

Self-propelling of small light-weight rotaries up to 20 inches in width is generally not necessary. Units of this size are light enough to be pushed with little effort. Beyond 20 inches, self-propelling is a necessary feature of rotary mowers. Other features to be considered when selecting a rotary mower are:

1. Safety—the blade should be completely covered so feet and fingers cannot contact the blade when the engine is running. If ejection chutes are present, they should be designed to deflect downward. This prevents stones and other objects, which may be picked up by the blade and ejected, from causing damage to person or property.
2. Blade should be firmly mounted to insure that it will never loosen up during operation.
3. Handle should be adjustable to suit operator.
4. Handle should stand up for easy storage.
5. Cutting height should be easy to adjust and have a range of 1 to 3 inches.
6. Blade should be of the "suction lift" design to create air turbulence. This, in general, gives a better cut and is necessary if the mower is to be used to mulch leaves.
7. Wheels should be large enough to permit easy operation.

Sometimes the home owner may find advantageous to own both a reel an rotary mower. This is particularly tru if a mountain or lake shore lawn is to b maintained, in addition to the home law One manufacturer has a portable engi unit called a "Power-Handle", which ma be transferred to either type of mower i a matter of a few minutes. In additio this same power unit drives a tiller, edge trimmer, snowplow, sprayer, pump, an generator. This new concept for yea around yard care permits the home own to economically possess several necessa lawn and garden maintenance units, a powered by a single easily interchange engine with associated handle and co trols.

Caring for the Mower. Lasting an satisfactory operation of the lawn mow may be obtained by following a routi program of care. The first step is to car fully read the service manuals (engi and mower) supplied with the machin Become completely familiar with t location of all bearings, bushings, an moving parts which require oil or greas Keep a clean supply of oil and gasoli on hand. Change crankcase oil as ofte as recommended in the service manua Check and tighten all loose nuts regularl

After each operation, brush away dus dirt, and grass clippings which may lea to overheating if permitted to accumula around the engine; fill the tank with gas line; oil moving parts with grade of o recommended by the manufacturer; an store in a clean dry space.

At least once a year, take the mow into an authorized service shop f sharpening and replacement of wor parts. For winter storage, drain the fu tank and crankcase, and lightly brus all metal parts with oil.

Fertilizer Spreaders and Seeders

A spreader is almost essential for un form and even distribution of fertiliz and seed. Hand application of fertiliz (and haphazard mechanical application a well) often results in alternate light an dark streaks in a lawn.

Fertilizer spreaders vary in width, ease of operation, accuracy, durability, and construction. As a general rule, a 24-inch spreader is adequate for lawns of 5000 to 10,000 square feet. Smaller and larger sizes are suggested for lawns smaller than 5000 square feet and larger than 10,000 square feet respectively.

Spreaders should have large wheels—at least 10 inches in diameter and wide enough to facilitate easy pushing. Accurate, easily operated control mechanisms and calibrated settings for different materials and seed insure uniform distribution at the desired rate of application. A good spreader will have a durable force-feed agitator which also aids uniform distribution.

It is important that taking apart a spreader and cleaning the agitator and bottom side plates be easily done. Preferably, the slide plates or shutters should be of a corrosion-resistant material. After each use, the spreader should be thoroughly cleaned, dried, and oiled. Most fertilizer materials are corrosive and, unless these steps are taken, may cause excessive rusting or corrosion which will reduce the life and operating ease of the spreader.

Aerators

The cultivation of turf grass is recognized as a necessary step in a sound lawn maintenance program. Cultivation by the use of hollow-tined spoons and spikers will not mar the beauty of the lawn, but will improve water infiltration and movement, as well as permit the deep placement of lime and fertilizer. These factors in turn promote superior root growth which results in a more vigorous, healthy turf.

Small hand forks with two or three hollow tines are satisfactory for correcting and improving small localized hard spots where grass does not grow very well. To aerate the entire lawn with this type of tool, however, is entirely too laborious and time consuming. Large power-driven units, such as are used on golf greens, are desirable for cultivating the entire lawn. Often these units may be rented from a local garden supply center, or a lawnkeeping service may be employed to custom aerate the lawn.

Spikers or spike disks may be used to advantage when seeding becomes necessary.

Irrigation Equipment

Many and varied types of lawn irrigation equipment are available. They range from nozzles attached directly to the garden hose, to completely automatic irrigation systems which require merely the turning of a valve or setting a dial. By far the most common method of irrigating lawns is the use of a sprinkler and garden hose.

Satisfactory irrigation equipment should apply water uniformly and at a rate and manner which the soil can absorb. In general, a sprinkler should deliver about ½ inch of water per hour and disperse it uniformly throughout the pattern. If a greater volume of water is discharged, the soil may be unable to absorb it and run-off occurs.

The inside diameter and length of hose play an important part in proper water application. The larger the diameter, the larger will be the volume of water carried, irrespective of pressure. Operating pressures reduce as hose length increases—no matter what the faucet pressure, a small, long hose may preclude satisfactory operation of certain types of sprinklers.

Sprinkler performance may be readily checked by setting a series of coffee cans, spaced at 2-foot intervals, in a straight

Hand aerifier is adapted to medium-sized lawns.

West Point

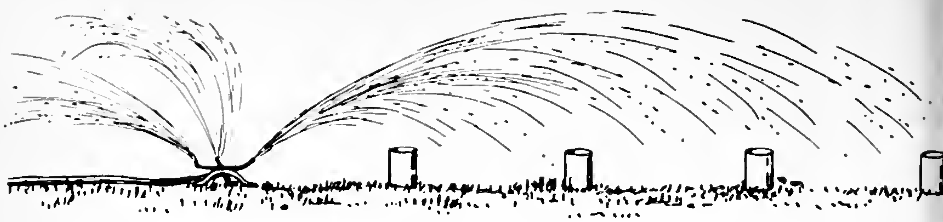


Diagram to show method of checking sprinkler performance (see text).

line from the sprinkler to the edge of the distribution pattern. Run the sprinkler for 20 to 30 minutes; observe or measure the volume of water caught in each can. If the volumes vary greatly a new and different sprinkler is recommended.

Edgers and Trimmers

Edging around flower and shrub beds and along walks and driveways, combined with trimming of grass adjacent to buildings and fences, gives the lawn area an appearance of finished grooming.

Power edger and trimmer for use around walks, drives, and flower beds.

Courtesy Toro Manufacturing Corporation

At one time, trimming and edging wa perhaps the most tedious and time-con suming chore associated with lawn car Hand shears, hoes, spades, and hatchet were often employed in an effort to attai a finished appearance. In recent years, wide array of equipment has becom available for this purpose. Mechanize trimmers and edgers have reduced th time and effort required to achieve th desired appearance.

Edgers and trimmers are available a independent and combination units. Som are hand operated and some powered– electric and gasoline driven. Powere units are recommended if extensive edgin and trimming are necessary. Operatin manuals should be consulted for care an maintenance of these units.

Sprayers

Sprayers are necessary for the prope application of chemicals to control weed diseases, and insects. They may also b used to apply liquid fertilizer.

Small knapsack sprayers (2- to 5-gallo capacity) are ideal for localized sprayin and are generally satisfactory for th application of herbicides and insecticid on lawns up to 5000 square feet. Pow operated sprayers of 10 or more gallo capacity have a much wider range o adaptation. They are ideal for sprayin lawns, shrubs, fruit, and ornamental tree as well as gardens.

Sprayers should be constructed of materials that resist corrosion and of a design that permits easy disassembly for complete cleaning. Extreme caution must be exercised in cleaning after using 2,4-D and similar materials. This is especially true if the sprayer will be used to apply insecticides in the garden or on flowers, shrubs, or trees at a later date. Authorities almost unanimously recommend an extra sprayer to be used only for the application of 2,4-D.

Sweepers and Carts

A lawn sweeper is desirable for the gathering of excessive clippings (assuming a catcher is not used on the mower), leaves, and other debris that may accumulate on the lawn. It may also be used to sweep sidewalks, driveways, and parking areas.

Carts are useful in hauling topsoil, potting soil, debris, and organic refuse for the compost pile. They are also handy for transporting tools, sprinklers, hose, and other miscellaneous items.

Maneuverability, ease of operation, and a "basket" of adequate size are factors to be considered in selecting a sweeper or cart. They are available as hand- and motor-propelled units.

Miscellaneous Items

Items such as rollers, which are used only on special occasions, may be rented or borrowed when needed. Stock lawn and garden items such as hose, rakes, shovels, trowels, etc. should be kept on hand. These items should always be cleaned and wiped with an oily cloth after each use. Such treatment will prevent rusting and prolong the life of the equipment.

Adequate dry storage space for these and all other maintenance items will prolong the usefulness of equipment, and add appreciably to trouble-free operation and satisfaction in use.

Roche

One-wheeled mower (edging mower) is useful for mowing grass along edges of flower beds.

Schery

Lawn sweeper is useful, but not essential for sweeping up leaves and clippings, and for sweeping walks, driveways, etc.

Author photo

Properly maintained turf will stand heavy use and abuse.

TURF GRASSES FOR RECREATION AREAS

. . . and the makers of home lawns can read also with profit

C. K. Hallowell

PERFORMANCE is important for the athlete or the individual out for exercise and recreation. When the contest or physical diversion is outdoors on a grass-covered area, the participant expects the turf grasses to give good performance also —it assists him in the full enjoyment of the game.

The person putting, bowling on the green, playing croquet or tennis needs a closer-cut grass than the football, soccer, lacrosse, or baseball player. But all want a dry, firm, "fast" surface. They expect a resilient cushion of grasses to provide them with a good surface on which to play the game.

To give all the players the type of turf surface required for their games, it is necessary to know the grasses which give the turf coverage desired, how to handle the soil to promote good growth, and to understand the turf management practices important to follow once the turf grass playing area is established.

Grasses for Sports Areas

For the close-clipped area, mowed at approximately 1/4 inch, creeping bentgrasses give the best performance. Varieties such as ARLINGTON, CONGRESSIONAL, and PENNLU are leaders, all grown from stolons. These heal rapidly when injured. The Colonial strains of bent, including ASTORIA and HIGHLAND, are included in seed mixtures where the height of cut is 1/2 to 3/4 inch. For grass tennis courts these bents usually predominate.

The improved strains of Bermuda grass, developed at Tifton, Georgia, by Dr. Glenn Burton and selected by Golf Course Superintendents in Florida, give a uniform surface for putting and bowling. The lawn bowlers in southwestern United States like the new selections of Bermuda. None of these are seed producers, making the use of stolons necessary for establishing a new turf area. All strains thrive when temperatures are high. They respond to liberal applications of

nitrogen fertilizers, and require less water than the bentgrasses.

U-3 Bermuda has more resistance to low temperatures than other strains and is being grown further north than other types. It is fast gaining popularity along the eastern seacoast and westward to St. Louis and Kansas City. In these areas crabgrass comes in rapidly because the cool-season grasses rest when temperatures are high. U-3, after becoming firmly established, continues to make a good playing surface in the late fall and early spring, even though it lacks any green color. It shows great possibilities for metropolitan playground areas where there is intense use during the summer.

Kentucky bluegrass grows over a wide range of conditions. It is included in most seed mixtures where cool-season grasses are used. The height of cut must be 1 inch or above. Kentucky bluegrass develops the "take care of yourself" characteristic during high heat periods—i.e., it rests when hot, and therefore presents a poor appearance during summer heat. But, if soil nutrients are present to its liking, growth starts again in cooler weather. A weakness of common Kentucky bluegrass is its susceptibility to leafspot. This disease appears in the spring and thins the grass when the plant should be making its best growth.

Merion Kentucky bluegrass is an improved strain that produces a dense turf, responds to heavier fertilization than common Kentucky blue, is highly resistant to leafspot diseases, likes cutting slightly lower than an inch, but objects to liberal amounts of water. Seed costs more than common Kentucky blue but a smaller amount is necessary to give initial coverage. MERION predominates in a number of outstanding football fields.

Tall fescues include KENTUCKY 31 and ALTA. Both perform well under intense play due to their deep rooting. They must be seeded heavily to avoid "bunchy" growth. Fertilization is needed spring and fall. ALTA thrives best in western United States, with the KENTUCKY 31 enjoying popularity in the East. A survey of athletic fields in Pennsylvania, New Jersey, and New York showed that KENTUCKY 31 fescue, bluegrass, and perennial ryegrass were the three grasses to include in the seed mixture to insure good turf with average maintenance.

Fine-leaf fescues (Chewings and red fescue) are often included in athletic field mixtures. They grow best in well-drained sandy soil in the cooler climates. Their fertility requirements are lower than other cool-season grasses but when injured they do not recover as rapidly.

Ryegrass starts fast and is a good grower to cover areas where it is difficult to get the permanent grasses well-established. Perennial ryegrass, being tougher than the annual or domestic ryegrass, is the one to include in seed mixtures for athletic fields cut at the height preferred by the tall fescue grasses.

Playing Fields Need Good Soil

A porous soil that has firmness is desired by the player as well as the grass. Drainage is of primary importance to produce porosity—this includes drainage underneath and on the surface. Tiles laid under the fields during construction are practical for the below-surface drainage. The turtleback football field, having an 18-inch drop from the center to the side lines, takes care of surface drainage.

Soils composed of a high percentage of sand and a maximum of 15% by volume of a peat material for organic matter give the desired physical condition. The organic matter content will be increased if there is always a good coverage of the turf grasses. The changing root growth of well established turf grasses provides a constant breaking down of old roots into organic matter.

Fertilizer and Lime Are Needed

Good practices call for liberal applications of complete fertilizer and needed lime at time of construction. After the turf grass is established, soil tests are the best guides in determining the required amounts of lime, phosphate, and potash. The nitrogen variations brought on by weather conditions are so great that it is futile to test for this element. Experienced managers have found that heavy

Sampling tool provides easy method of determining depth of watering, compaction, and nature of the soil under sod (also see page 101). This fine-textured lawn is creeping bentgrass.

amounts of organic nitrogen in the fall and light applications in spring are best for the cool-season grasses. If Bermuda grass is grown, apply nitrogen from late May to mid-September every three or four weeks.

The soils on heavily used athletic fields soon become compacted. Compaction interferes with the normal growth of roots and prevents air, water, and fertilizer from entering the soil. Cultivation of the soil at least each spring and fall, and again at the end of the playing season, reduces compaction, and does not interfere with the grasses. Either power-operated or tractor-pulled aerifiers are practical to cultivate fields that receive heavy use often when the soil is wet.

Care of Turf on Playing Fields

Correct management is as important as selecting the right grasses for the game to be played on the field, supplying soil nutrients, and keeping the soil friable.

Those who are responsible for the management of turf grass areas on institutional playing fields, in parks, etc., have opportunities to keep informed. There are conferences each winter along the eastern coast at Massachusetts, New York, New Jersey, Pennsylvania, and Maryland. Similar conferences are held in many states throughout the country. At these meetings one gets the fundamental facts about growing turf grasses, and can exchange experiences with others engaged in similar work.

County agricultural agents often stage field demonstrations and hold meetings to point out good practices for maintaining the grasses. Manufacturers of equipment and fertilizers, and distributors servicing athletic field installations often have circulars or bulletins outlining experiences with their products. TURF MANAGEMENT written by H. Burton Musser is a book that gives practical information on growing turf grasses for different purposes.

Standard Maintenance Operations

Mowing. Frequent mowings are necessary so that there is never an excessive amount of leaf area cut off at one time. Mowing, like the pruning of trees, controls growth. The height of cut will depend upon the kind of grass. Bermudas, zoysias, and bentgrasses can and should be cut closer than the bluegrasses, fescues and other upright growers. Standard heights are a maximum of ½ inch for the former and not less than 1 inch for the latter.

Aerification. Soil compaction soon develops as a playing field is used. This results in a hard playing surface and a tight soil. Rainfall or irrigation water and soil nutrients are unable to go down to the feeding roots of the grasses. Cultivation of soil of all grass-covered fields and playing areas is needed. Power driven or tractor-drawn aeration tools loosen soil effectively.

When the soil is aerated to a depth of 3 to 4 inches during the spring months there is an increase in root growth. Spring is the season when grass roots make their greatest growth. Often athletic fields are renovated early in the fall and again at the end of the playing season. Aerification is a "first" when starting an improvement program. When excessive rain results in water-logged soil the use of aeration tools allows air to get into the soil and saves the roots from suffocation. In many instances, the

grasses on fields have been saved by providing air to replace an over-supply of water.

Water is sometimes needed to assist grasses to withstand a drought period. The bentgrasses that cover lawn bowling rinks and putting greens require ample water. Careful examination of the soil to determine moisture prior to watering is important. Also, check depth of penetration to be sure adequate water has been applied. Frequent, light watering causes soil to puddle and encourages roots to grow close to the surface. Deep watering every 2 or 3 weeks usually is sufficient for the heavier types of soil. For sandy soils, water must be applied at shorter intervals.

Fertilizing the grasses on athletic fields calls for using a complete fertilizer such as a 5-10-5 or 10-6-4 annually, either early spring or fall. This one application will supply moist soils with sufficient phosphate and potash. Two additional applications of nitrogen fertilizer are in order for the higher-cut grasses and four to six for the close-cut bents.

Weed Control

Weeds appear in injured grasses and, if the turf is not kept dense, crabgrass often invades during the early summer. The chemical 2,4-D is recognized as the best way to get rid of broad-leaf weeds such as dandelion (*Taraxacum*) and buckhorn (*Plantago lanceolata*). Use the lightest amount recommended by the manufacturer. This herbicide is slow in its action but effective when correctly distributed.

Disodium methyl arsonate (Sodar) is a new herbicide showing much promise for controlling crabgrass. Again, follow manufacturer's recommendations and apply when crabgrass appears above the grass. Follow-up sprays usually are needed, primarily to control plants that germinated after initial application.

Potassium cyanate is effective against crabgrass when applied as seedheads are developing. Phenyl mercury compounds check crabgrass when used early and frequently.

Author photos

Convenient tool for taking sod plugs to patch small damaged spots in turf.

Lawn owners have often resorted to close, frequent mowing following by raking and removing clippings. Vertical mowing (rotary mower) is an aid in removing seedheads before they mature.

Insects

A field may be in an area where June beetles are active. While the beetles are on the wing, they like to deposit their eggs in the best turf grass available. DDT stops the mature June beetle but not white grubs. Heptachlor, Aldrin, and Dieldrin are insecticides which experimental workers have found to kill all grubs. Chlordane also is an effective insecticide to kill all types of grubs. Only a small amount of insecticide is required but it must be distributed uniformly. Directions on each container tell how much to use.

Turf Nursery

A nursery of the same grasses as are in the playing field is important. When wear has been excessive or the grasses have been injured, either sod or plugs from the nursery may be transferred to repair the damaged area. One of the improved grasses may be grown in the nursery and moved to the field in instances where the introduction of a better grass is required.

LIST OF GRASSES OF ECONOMIC IMPORTANCE IN THE U.S.A.
(Exclusive of pasture grasses)

The Grass Family (Gramineae) is a distinctive family of flowering plants, and probably the most successful of all of them. Grasses, as natural vegetation, cover about 20 per cent of all the land surface of the world, and some 60 per cent of the U.S.A. The latter amounts to approximately 1 billion acres and supplies about half the total livestock feed for the United States.

Of the approximately 6000 differen[t] kinds of grasses known to man, most gro[w] only in the wild. Fewer than 50 gener[a] (the 6000 species fall into about 50[0] genera) have thus far been of any con[-]siderable importance in man's econom[y]. Lawns around homes are important t[o] civilized man, but represent only one o[f] the many contributions that grasses mak[e] to his well-being.

Common Name	Scientific Name	Region of Origin
Principal Turf Grasses		
Bent, Colonial	*Agrostis tenuis*	Europe
Bent, Creeping (includes ARLINGTON, CONGRESSIONAL, and PENNLAWN)	*Agrostis palustris*	Europe, E. North Americ[a]
Bent, Velvet	*Agrostis canina*	Europe
Bermuda Grass variety U-3 (hardier than the original Bermuda)	*Cynodon dactylon*	Europe
Bluegrass (includes regular Kentucky and its variety MERION)	*Poa pratensis*	Europe
Rough-stalked	*Poa trivialis*	Europe
Carpet Grass	*Axonopus affinis*	Virginia to Louisiana[,] Tropical America
Centipede Grass	*Eremochloa ophiuroides*	China
Fescue		
Chewings	*Festuca rubra* var. *commutata*	Europe, Asia, and North America
Creeping Red	*Festuca rubra* var.	
Meadow, or Tall	*Festuca elatior*	Europe
Korean Lawn-grass (includes MEYER Z52, etc.)	*Zoysia japonica*	Japan, China
Manila Grass	*Zoysia matrella*	So. Asia, East Indies
Redtop	*Agrostis alba*	Europe
Rye Grass		
Perennial	*Lolium perenne*	Europe
Italian (domestic or annual)	*Lolium multiflorum*	Europe
St. Augustine Grass	*Stenotaphrum secundatum*	South Carolina to Texas[,] Tropical America

There are also many ornamental kinds of grasses for gardens, both hardy annuals and large perennials, prized for their growth habit, their feathery or other[-]wise ornamental foliage, or their flowe[r] heads (inflorescences).

Principal Crop Grasses, Including Cereal Grasses

Bamboo	*Bambuseae* (many species)	
Barley	*Hordeum vulgare*	Eurasia
Maize (Indian Corn)	*Zea mays*	Latin America
Oats	*Avena sativa*	Eurasia
Rice	*Oryza sativa*	East Indies
Rye	*Secale cereale*	Eurasia
Sorghum	*Sorghum vulgare*	Mediterranean Region
Sugar Cane	*Saccharum officinarum*	Old World
Wild Rice	*Zizania aquatica*	North America

Common Weed Grasses of Lawns and Gardens in Temperate Regions

Muenscher, WEEDS, Macmillan, New York, 1935 (2nd ed., 1955) describes about 50 grasses that are often unwanted invaders, but fewer than a half dozen are important in lawns.

Annual Bluegrass	*Poa annua*	Europe
Crabgrass		
Hairy	*Digitaria sanguinalis*	Europe
Smooth	*Digitaria ischaemum*	Europe
Goosegrass	*Eleusine indica*	Old World
Quackgrass	*Agropyron repens*	Europe

AN EXPERIENCE WITH OVER-FERTILIZATION

The following is a brief report on results of seasonal feeding of a well-established weed-free bluegrass lawn.

The entire lawn was fed early in March with a 10-6-4 fertilizer at the rate of 25 pounds per 1000 square feet. Growth was excellent in the 10 weeks after the first feeding and continued so to the date of this report (July 30).

The last week in May, a slow-release fertilizer (38 per cent nitrogen) was applied to a section of the lawn, here designated as Plot No. 1, at the maximum rate indicated on the bag (20 pounds per 1000 square feet). At the same time Golden Vigoro was applied to an adjacent but identical area (Plot No. 2) at the rate of 40 pounds per 1000 square feet. Rain followed within an hour of the application of the two fertilizers.

Growth rates were not discernibly different in Plots 1 and 2, but by 3 weeks after the late May application there were several brown areas on Plot 1 and none in Plot 2. The Plot 1 difficulty was determined to be brown patch disease. Such a development in a heavily fed lawn is not new (see page 125) but it is of more than passing interest to note that one of the new "slow-release" fertilizers apparently released nitrogen rapidly enough to make the lawn susceptible to the brown patch fungus. In this experiment the cost of the high nitrogen fertilizer was three times that of the fertilizer used on Plot No. 2 (per thousand square feet of area).

Apart from the observation on higher cost (for this experiment), the obvious conclusion may be drawn that over-fertilization can increase susceptibility to disease—yet at the same time not give any better results in terms of growth. "Feed your lawn" is still excellent advice and one of the important keys to good lawn making; but *do not overfeed.*

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BROOKLYN BOTANIC GARDEN RECORD

PLANTS & GARDENS

Broad-Leaved Evergreens for Every Garden

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East-West-
North-South

How to
Propagate

Landscape
Uses

AUTUMN
1956

EW SERIES
NO. 3

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Peter K. Nelson, *Associate Editor*

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Except where noted, all drawings by P. K. Nelson

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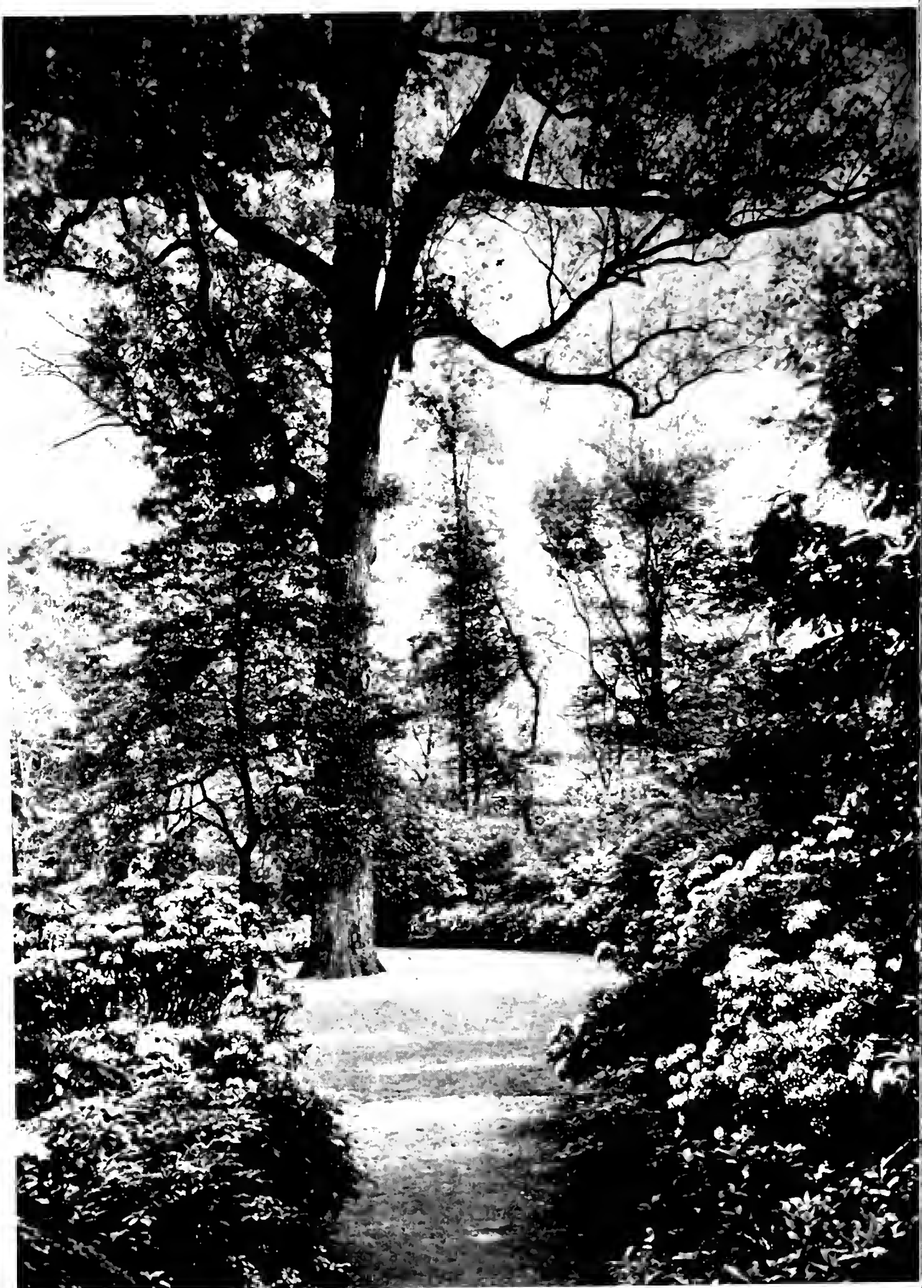


Gottscho-Schleisner

Broad-leaved evergreens effectively used in a natural planting.

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES
BROOKLYN BOTANIC GARDEN
1000 WASHINGTON AVENUE
BROOKLYN 25. NEW YORK
TELEPHONE: MAIN 2-4433

Autumn 1956

Great numbers of plants in the tropics keep their broad green leaves throughout ıe year. In a sense, therefore, mild climates are headquarters for broad-leaved vergreens. They are referred to here as "b.l.e.", in contrast to the pines, firs, pruces, and others whose needle-like leaves make them "narrow-leaved evergreens."

Every man-created landscape ought to include appropriate b.l.e. (as far orth as they will grow)—which comes to the point of this issue.

One of the important facts about b.l.e. is that northward from the tropics here are fewer of them. In general they cannot stand the colder winters as well as he deciduous trees and shrubs—which shed their leaves in autumn. But some f the b.l.e. are surprisingly adaptable; they are evergreen in the Deep South, ınd deciduous further north. In really cold climates, they do not survive at all.)thers, like Burford holly, will keep their leaves through rather extreme winter old and wind, as well as stifling summer heat and occasional drought.

Still others, like the southern magnolia and camellia, never become deciduous. They hold their leaves as far north as they will grow. If colder than they can tand, they simply die with their leaves on.

Our Guest Editor and Editorial Committee have turned to experts in typical geographical areas over much of the U.S.A., except tropical or near-tropical Florida (which deserves an entire handbook of its own). Something over a ıundred of the most widely used b. l. e. trees, shrubs, vines and ground covers ıre included here. Many of them are exotic types that originally came from far away parts of the world.

Strange as it may seem, there are frequently localized areas in the colder North where winter is kinder to plants than it is in the region as a whole. These "microclimate" locations are usually shaded from winter sun, and the soil is well drained (good air drainage, too). Bearing this in mind, many readers with at least mild urge for horticultural adventure and backyard research will try to discover such spots, and grow a few varieties beyond the zones that are usually considered their northern limit.

To make this Handbook of the greatest possible usefulness throughout the country, we have based it on authoritative reports from nine geographical regions of the United States (see page 223).

Sincerely,

George S. Avery, Jr.

Director

As sources of broad-leaved evergreens, etc., we are glad to recommend the firms whose ads appear on pages 271 and following.

Gottscho-Schleisner

THIRTY OF THE BEST BROAD-LEAVED EVERGREENS

TO MANY gardeners, especially those in regions having cold winters, "evergreens" have long meant only narrow-leaved evergreens—pines, firs, yews, etc., but in the last decade or so there has been an increasing interest in broad-leaved evergreens for gardens.

The plants in this list have been selected because of their beauty and general usefulness, the comparatively wide range over which they can be grown, and their hardiness.

Hardiness is indicated by zones (zone map on page 223). It must be remembered that such indications are only approximate—within any zone, or even within one garden, there can be many kinds of climate. Moreover, variations among plants occur, and occasional individuals may be found that are much more resistant to cold (or to drought or heat, etc.) than its fellows. Valuable service in finding such plants can be performed by amateurs who are willing to experiment.

Information in the list has been supplied by Donald G. Huttleston of Longwood Gardens, Clarence E. Lewis of the Long Island Agricultural and Technical Institute, F. G. Meyer of the Missouri Botanical Garden, Brian O. Mulligan of the University of Washington Arboretum, Leon C. Snyder of the University of Minnesota, and Donald Wyman of the Arnold Arboretum.

Bearberry, Kinnikinnik

Arctostaphylos uva-ursi

Hardiness: Very hardy, can be grown in most parts of the United States.

Habit and Use: Creeping plant, makes mats up to about 8 inches. Useful as ground cover or rock garden plant and for holding sandy soils in place.

Flowers and Fruit: Small pinkish flowers in spring followed by red berries.

Leaves: Small, to 1 inch long, shiny, turning bronze in fall. Should be planted in full sun in well drained soil; will grow in sand.

McFarland

Bearberry (*Arctostaphylos uva-ursi*)

Wintergreen Barberry *Berberis julianae*

Hardiness: Hardy in Zone 5 and south; grows only fairly well in Northern Illinois, sometimes shows winter injury on Long Island but recovers in spring.

Habit and Use: Shrub growing to 6 feet, very dense. Excellent for hedges.

Flowers and Fruit: Yellowish flowers in clusters in spring; blue-black berries in fall.

Leaves: Spiny-toothed, growing to 3 inches long.

Does best in moist, well drained light loam soil.

Wintergreen Barberry (*Berberis julianae*)

Buhle

Threespine Barberry *Berberis triacanthophora*

Hardiness: Hardy from Zone 5 south; grows quite well on Long Island, well in the Pacific Northwest.

Habit and Use: Shrub growing to 3 or 4 feet. Good for low hedges.

Flowers and Fruit: Creamy white flowers with a reddish tinge in clusters in spring; blue-black berries in fall.

Leaves: Narrow, toothed, up to 2 inches long.

Does best in moist, well drained light loam soil.

Littleleaf Box *Buxus microphylla*

Hardiness: Hardy from Zone 5 south, will stand lower temperatures than common box.

Habit: Shrub growing to 3 feet, sometimes prostrate.

Varieties: *B. microphylla compacta* is smaller, reaching 12 inches or less after many years' growth.

B. microphylla japonica is taller, to 6 feet, with larger leaves.

B. microphylla koreana grows to about 2 feet; is the most hardy box.

For culture see pages 235 to 238.

Common Box *Buxus sempervirens*

Hardiness: Hardy from Zone 5 south, on Long Island the tips may be injured in winter.

Habit: Shrub or tree growing to 25 feet.

Variety: *B. sempervirens suffruticosa* is small, very slow-growing, with leaves up to ¾ inch long.

For culture see pages 235 to 238.

Heather *Calluna vulgaris*

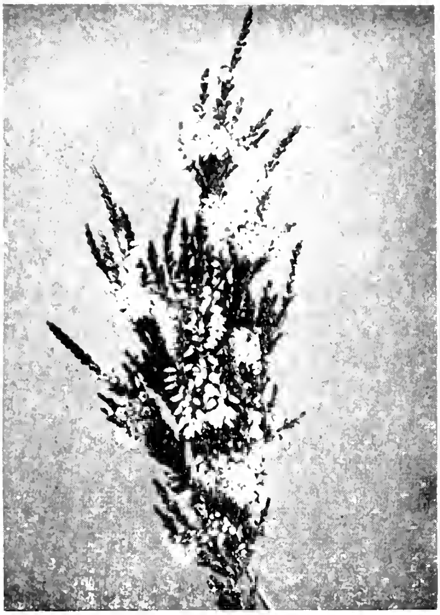
Hardiness: Hardy in Zone 4 and south.

Habit and Use: Small shrubs which will grow to about 3 feet, but can form carpets only 6 to 8 inches tall. Good for ground cover or rock garden plants.

Flowers: Very small, in spikes 6 to 8 inches long, in summer. Purplish but ranging from white to red in the varieties.

Leaves: Minute, scale-like, turning bronze in autumn in some varieties.

Require a light, acid soil that is not rich. On rich soils plants become leggy and die. Will not stand drying out. Will grow in shade, but need sun for blossoming.



Buhle

↑ Heather (*Calluna vulgaris*)

↖ Threespine Barberry (*Berberis triacanthophora*)
Courtesy C. E. Lewis

← Common Box (*Buxus sempervirens*)
McFarland

Roche

→ Littleleaf Box (*Buxus microphylla*)

Common Camellia *Camellia japonica*

Hardiness: Commonly rated as hardy in Zone 7 and south, but some varieties are hardy as far north as Yonkers, New York (Zone 5, see page 264).

Habit and Use: Shrub or tree to 25 feet. Superb specimen plants or screen plantings, can be espaliered.

For culture, varieties, and uses see page 264 to 271.

Sasanqua Camellia *Camellia sasanqua*

Hardiness: Hardy from Zone 7 south, probably a little less hardy than *C. japonica.*

Habit: Shrub or tree growing to 20 feet.

For culture, varieties, and uses see pages 264 to 271.

Garland Flower *Daphne cneorum*

Hardiness: Hardy at least as far north as Zone 4, can be grown in parts of North Dakota (Zone 3) with some protection.

Habit: Low shrub, sometimes growing to 6 feet, but usually less.

Flowers: Clusters of small, rose-pink, fragrant flowers in spring.

Leaves: Small, about 1 inch long.

Will do well in either acid or alkaline soil; roots should be kept cool and moist.

Thorny Elaeagnus *Elaeagnus pungens*

Hardiness: Hardy from Zone 7 south; can be grown in sheltered spots as far north as New York City.

Habit: Small tree or shrub growing 12 to 15 feet tall.

Flowers and Fruit: Small, very fragrant flowers in October and November. Small fruit turning red in spring.

Leaves: Glossy, dark green, silvery underneath.

Will do well in difficult places; likes full sun. The variety *E. pungens maculata* has large golden-yellow blotch in centers of leaves, is useful for winter color. Other variegated forms also available.

Roche

Common Camellia (*Camellia japonica*)

Courtesy F. de Vos

Sasanqua Camellia (*Camellia sasanqua*)

Garland Flower (*Daphne cneorum*)

McFarland

Thorny Elaeagnus (*Elaeagnus pungens*)

Buhle

Wintercreeper *Euonymus fortunei*

Hardiness: Hardy from Zone 5 south and in sheltered spots a little farther north.

Habit and Use: Varies from clinging vine to sub-shrub. Useful for ground cover, wall cover, in foundation plantings or as specimen plants, depending on variety.

Flowers and Fruit: Flowers insignificant, rare except in two varieties; fruit showy in the two varieties which bear abundantly.

Varieties: *E. fortunei carrierei* is shrubby, has very glossy, dark green leaves to 2 inches long; fruits abundantly, red berries with pink capsules.

E. fortunei colorata spreads, grows to about 1 foot, makes excellent ground cover. Leaves to 1 inch long, turn purple-red in fall and winter.

E. fortunei minima is slow-growing, has small leaves less than ½ inch long.

E. fortunei reticulata creeps or climbs, has large dark green leaves variegated white along veins.

E. fortunei vegeta is semi-shrubby, grows to about 5 feet. Leaves rounded, to 1½ inches long. Called evergreen bittersweet because of its abundant orange fruit.

Euonymus does not require acid soil, will tolerate shade. Watch out for scale (see PLANTS & GARDENS, Spring 1955, page 19).

English Ivy *Hedera helix*

Hardiness: Hardy from Zone 5 south, it can be grown in protected areas in Zone 4.

Habit and Use: Vine, clinging to walls and other supports or trailing on ground, may reach 90 feet or more. Useful on walls, fences, and as an evergreen ground cover.

Flowers and Fruit: Flowers greenish, in round clusters; fruit black.

Leaves: Dark green, 3- to 5-lobed, to 4 inches long. Not lobed on mature fruiting branches.

Variety: *H. helix baltica* is somewhat smaller leaved and hardier. Many other varieties available, differing mostly in leaf size and shape.

English Holly *Ilex aquifolium*

Hardiness: Hardy from Zone 6 south.

Habit: Tree growing to 40 feet in height.

For culture and uses see pages 244 to 247.

Chinese Holly *Ilex cornuta*

Hardiness: Hardy Zone 6 south; some strains can be grown in parts of Zone 5 with protection, although it is not proving as hardy in St. Louis, Missouri (middle of Zone 5), as first thought to be. At *Ottawa, Kansas,* it has withstood summer temperatures reaching 109° to 118°F. (Reader's information.)

Habit: Shrub growing to 9 or 10 feet.

Flowers and Fruit: Flowers inconspicuous, followed by bright red berries which last through the winter.

Leaves: Dark green, shining, usually 5-spined. In variety *burfordi* they are darker, mostly with one spine.

Culture as for other hollies, see pages 239 to 243.

Wintercreeper (*Euonymus fortunei carrierei*) →

← English Ivy (*Hedera helix*)

English Holly (*Ilex aquifolium*) ↙

Chinese Holly (*Ilex cornuta*) ↓

Roche photos

Japanese Holly *Ilex crenata*

Hardiness: Hardy in Zone 6 and south, probably some strains farther north. Persists under snow in Minneapolis, Minnesota.

Habit: Shrub growing to 20 feet.

Flowers and Fruit: Inconspicuous flowers; small black berries in fall.

Leaves: Dark green, shining, ½ to 1½ inches long.

Varieties: *I. crenata convexa* grows to 3 or 4 feet, is twice as broad as high.

I. crenata hetzi is much like *convexa* but leaves are elongate and it is perhaps hardier.

I. crenata helleri is dwarf, growing only to 1 to 1½ feet.

I. crenata latifolia has more rounded leaves.

I. crenata microphylla is most hardy, has leaves less than ½ inch long.

I. crenata rotundifolia has round leaves, tolerates sun better than others in Midwest.

For uses and culture see pages 239 to 243.

Inkberry, Gallberry *Ilex glabra*

Hardiness: Hardy into Zone 3, although at Minneapolis it kills back to the ground, coming up again from the base.

Habit and Use: Shrub to 10 feet, usually less. Can be used as specimen plant or for screen plantings.

Flowers and Fruit: Flowers inconspicuous, followed by small black berries in fall.

Leaves: Dark green, lustrous, 1 to 2 inches long.

Native, will grow in swampy areas.

American Holly *Ilex opaca*

Hardiness: Hardy in Zone 6, and possibly some strains in Zone 5.

Habit: Tree growing to 50 feet.

For varieties, culture, and uses, see pages 239 to 243.

Mountain Laurel *Kalmia latifolia*

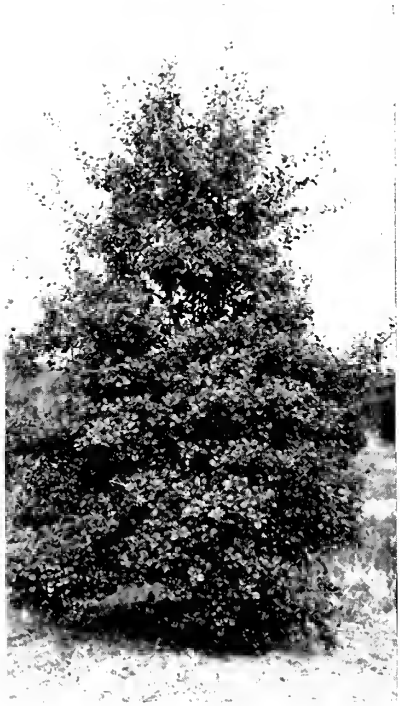
Hardiness: Hardy in Zone 4 and south, has been grown as far north as Minneapolis with shade and good snow cover.

Habit and Use: Shrub growing to 10 feet or more. Excellent for foundation plantings, on banks, and in natural plantings.

Flowers: Pink and white flowers in clusters produced abundantly in late spring or early summer.

Leaves: Shiny, to 5 inches long.
Requires acid soil. Will grow in shade, but needs sun to flower well.

←
Japanese Holly (*Ilex crenata convexa*)
Courtesy University of Washington Arboretum



McFarland
American Holly (*Ilex opaca*)
Courtesy University of Washington Arboretum

Buhle

↑
Inkberry
(*Ilex glabra*)

→
Mountain Laurel
(*Kalmia latifolia*)

Drooping Leucothoe *Leucothoe catesbae*

Hardiness: Hardy in Zone 4 and south, and has been grown as far north as Minneapolis with shade and good snow cover.

Habit and Use: Shrub growing to 6 feet, useful in borders, not so good as specimen plant.

Flowers: Small white flowers in attractive drooping clusters 3 inches long in late spring.

Leaves: Lustrous, dark green, to 7 inches long.

Needs light, peaty, acid soil.

Oregon Holly-grape *Mahonia aquifolium*

Hardiness: Rated hardy in Zone 5 and south, but can be grown in southeastern Nebraska, and near Chicago, Illinois, both in Zone 4.

Habit and Use: Shrub 3 or more feet high. Makes good thicket or tall ground cover.

Flowers and Fruit: Flowers small, yellow, fragrant, in spikes in spring. Edible fruit in summer, blue-black, grape-like berries.

Leaves: Glossy, dark green, compound with 6 to 9 leaflets. Leaflets are spiny much like holly leaves, may turn purple in fall.

Grows best in partial shade, needs protection from drying winds.

Leatherleaf Mahonia *Mahonia beale*

Hardiness: Hardy in Zone 6 and south.

Habit and Use: Shrub growing to 12 feet, good specimen plant.

Flowers and Fruit: Lemon yellow flowers, fragrant, in clusters in spring followed by bluish-black fruit.

Leaves: Compound, up to 16 inches long. Leaflets have fewer spines, are less glossy than those of *M. aquifolium.*

Prefers acid soil, partial shade.

Holly Osmanthus *Osmanthus ilicifoliu*

Hardiness: Hardy in Zone 6 and south, has been grown on Long Island fo 40 years.

Habit and Use: Shrub growing 18 to 20 feet high. Can be grown as handsom specimen plant, or clipped for hedge.

Flowers and Fruit: Flowers small, fragrant, in fall; bluish-black berries.

Leaves: Shining, dark green, spiny, resembling those of holly.

Can be grown in either sun or partial shade, does better in acid soil.

Drooping Leucothoe (*Leucothoe catesbae*)
→

Courtesy University of Washington Arboretum

Oregon Holly-grape (*Mahonia aquifolium*)
↓

Roche

McFarland
↑
Holly Osmanthus (*Osmanthus ilicifolius*)

Leatherleaf Mahonia (*Mahonia bealei*)
↓

Buhle

Japanese Spurge *Pachysandra terminalis*

Hardiness: Stated to be hardy from Zone 5 south, it can be grown in northern Illinois (Zone 4) and in Minnesota and North Dakota (Zone 3), so is worth trying in these zones.

Habit and Use: Creeping, grows to 12 inches tall. Very valuable ground cover.

Flowers and Fruit: Flowers small, white, in spring; fruit white, in fall.

Leaves: Toothed, dark green, lustrous, grow in whorls.

Grows best in acid soil and in partial shade.

Canby Pachistima *Pachistima canbyi*

Hardiness: Hardy in Zone 4 and south, can be grown in North Dakota and Minnesota.

Habit and Use: Low shrub growing to 1 or 1½ feet. Good for ground cover, for borders and low hedges, and in foundation plantings.

Flowers and Fruit: Insignificant.

Leaves: Narrow, to 1 inch long, dark green turning bronze in fall.

Requires acid soil and shade.

Mountain Pieris *Pieris floribunda*

Hardiness: Hardy in Zone 4 and south.

Habit and Use: Shrub growing to 6 feet. Useful in foundation and screen plantings, or as specimen plant.

Flowers: Small, white, nodding, in erect clusters in spring.

Leaves: Shining, to 3½ inches long.

Does best in light soil and partial shade.

Japanese Pieris *Pieris japonica*

Hardiness: Hardy in Zone 5 and south.

Habit: Shrub sometimes growing to 10 feet or more.

Flowers: Small, creamy white, in drooping clusters up to 5 inches long, in spring.

Leaves: Dark green, lustrous, to 3½ inches long.

Prefers acid soil, partial shade. Will grow in quite heavy shade, but blooms better if it gets some sun. Stands city conditions well.

← Japanese Spurge (*Pachysandra terminalis*)
Roche

Canby Pachistima (*Pachistima canbyi*)
↓ *Buhle*

↑ Mountain Pieris (*Pieris floribunda*)
Roche

→
Japanese Pieris (*Pieris japonica*)
Courtesy University of Washington Arboretum

Scarlet Firethorn *Pyracantha coccinea*

Hardiness: Hardy in Zone 6 and south.

Habit and Use: Shrub or tree growing to 20 feet. Useful for espaliering on walls, as specimen plants (in warm regions), can be trimmed for hedge although the necessary pruning for this will reduce the amount of fruit produced.

Flowers and Fruit: Flowers small, white, in flat clusters in early summer; fruit red or orange, abundant, showy in fall and winter.

Leaves: Small, may fall late in season in northern parts of range.

Variety: *P. coccinea lalandi* has orange-red fruits, is more vigorous and a little hardier than the species. It has been grown in Minneapolis, where it kills back to some extent (see page 223). Worthy of trial in sheltered spots or against warm walls as far north as Zone 3 .

Firethorns can be grown in neutral or slightly alkaline soil.

Rhododendron and Azalea *Rhododendron* spp.

Over 750 species of *Rhododendron* are known, at least three quarters of which are evergreen. The plants commonly called azaleas as well as those known as rhododendrons belong to the genus *Rhododendron*. There is no single sharp difference between them, but in general most rhododendrons are evergreen, most azaleas lose their leaves; leaves of azaleas are usually small and often have short hairs, those of many rhododendrons are large and have dots or scales beneath; the flowers of azaleas usually have five stamens, those of rhododendrons ten or more.

All require light acid soil (see page 199 for preparing acid soil in limestone regions).

Listed here are but five of the more hardy, beautiful species. See articles elsewhere in this issue for culture, varieties, uses, etc.

Carolina Rhododendron *Rhododendron carolinianum*

Hardiness: Rated hardy from Zone 5 south, but is satisfactory in Chicago area (Zone 4); is worth trying in protected sites in other parts of this zone.

Habit: Shrub growing to 6 feet.

Flowers: Pale rose-purple, in late spring.

Leaves: Up to 3 inches long, brown on underside.

Catawba Rhododendron *Rhododendron catawbiense*

Hardiness: Zone 4 south.

Habit: Shrub or tree growing to 20 feet.

Flowers: Lilac-purple, spotted with olive-green (white in variety *album*) in early summer.

Leaves: Up to 5 inches long.

Rosebay Rhododendron *Rhododendron maximum*

Hardiness: Zone 3 south.

Habit: Tree or shrub growing to 35 feet.

Flowers: Rose to purple-pink, spotted with green, in summer.

Leaves: Up to 10 inches long.

← Scarlet Firethorn (*Pyracantha coccinea*) *Buhle*

Carolina Rhododendron (*Rhododendron caroliniianum*) ↓

↑ Catawba Rhododendron (*Rhododendron catawbiense*)

Rosebay Rhododendron (*Rhododendron maximum*) *McFarland photos* →

Keiske Rhododendron *Rhododendron keiskei*

Hardiness: Zone 5 south.

Habit: Shrub growing to 10 feet.

Flowers: Pale yellow, in late spring.

Leaves: Up to 2½ inches.

Kurume Azaleas Hybrids of *Rhododendron obtusum,* especially variety *kiusianum.*

Hardiness: Variety *amoenum,* from Zone 5 south; the many hybrids from Zone 6 south to Zone 9 south.

Habit: Shrub growing to 3 feet.

Flowers: Many colors, both double and single; in variety *amoenum* they are bright magenta.

Leaves: Up to 1 inch long, only semi-evergreen in northern part of range.

Smirnow Rhododendron *Rhododendron smirnowi*

Hardiness: Zone 4 south.

Habit: Shrub growing to 18 feet.

Flowers: White to rose-red, in late spring.

Leaves: Up to 6 inches long, woolly beneath.

Leatherleaf Viburnum *Viburnum rhytidophyllum*

Hardiness: Hardy in Zone 5 and south, can be grown in parts of Zone 4, may not be completely evergreen in northern part of range.

Habit: Shrub growing to 9 feet.

Flowers and Fruit: Flowers small, white (pink in variety *roseum*), in flat clusters. Fruit, small red to black berries.

Leaves: To 7 inches long, shining, dark green, interesting wrinkled surface, woolly underneath.

Should have rich, well drained soil.

Common Periwinkle, Myrtle *Vinca minor*

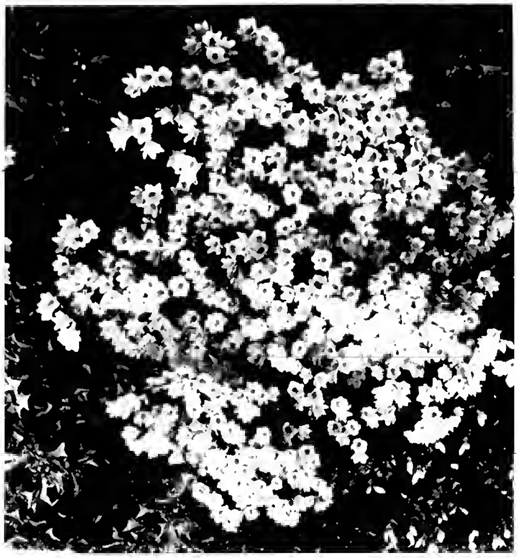
Hardiness: Hardy from Zone 4 south, but worth trying in parts of Zone 3, as it can be grown in parts of North Dakota.

Habit and Use: Trailing, one of the most useful ground covers.

Flowers: Lilac-blue, in spring.

Leaves: Lustrous, dark green.

Does very well in shade, but will also grow in sun; will grow on any but the poorest of soils.



↑
ske Rhododendron (*Rhododendron keiskei*)

↗
rume Azalea (*Rhododendron obtusum kiusianum* hybrid)
Roche

→
atherleaf Viburnum (*Viburnum rhytidophyllum*)
McFarland

↓
mmon Periwinkle (*Vinca minor*)
Richard Averill Smith

Courtesy University of Washington Arboretum

Sheltered and partially wooded slope is ideal for rhododendrons and many other broad-leaved evergreens.

BROAD-LEAVED EVERGREENS IN THE MIDDLE WEST

Experiences at the Morton Arboretum with plants of the Heath Family

E. Lowell Kammerer

THE almost complete absence of broad-leaved evergreens in Chicago area landscape plantings, an omission especially noticeable throughout the winter months and during the late spring and early summer blooming seasons, has stimulated a growing interest in this useful class of plants. This is surprising considering the special cultural requirements known to be essential to their successful establishment and maintenance.

Although broad-leaved evergreens had been previously tried in numerous locations within the Arboretum grounds, the desire to see what they would do under more controlled conditions motivated the establishment of the new collection in the spring of 1951. The site chosen for the experiment was in a wooded area where topography, exposure, land and air drainage, and protection seemed to more closely approximate ideal growing conditions

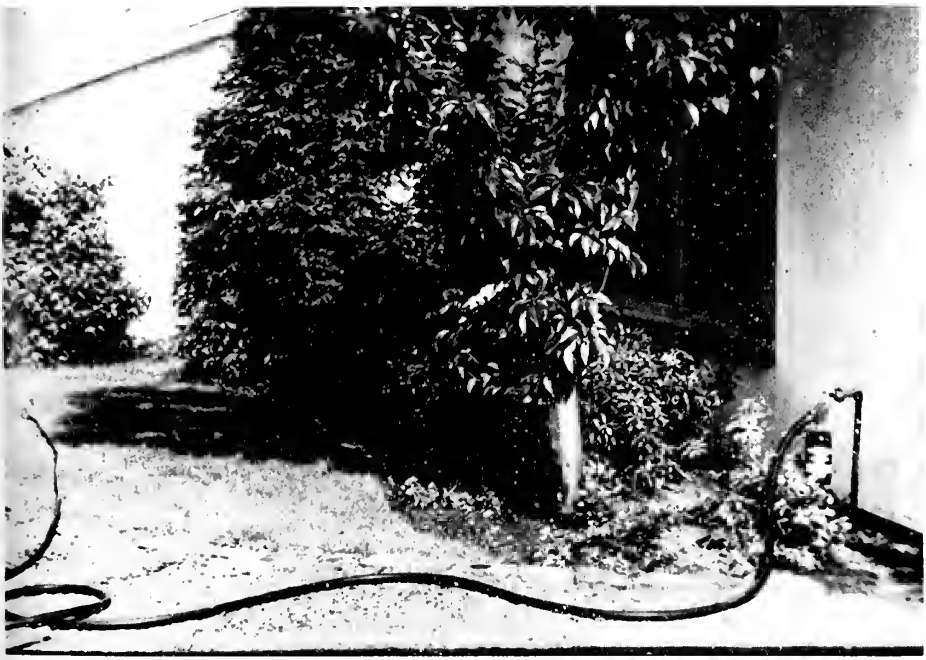
than any other location in which previous trials had been made. The soil had to be specially prepared, of course, an operation completed during the fall of 1950, preceding the initial planting done the following spring.

Contrary to the prevailing belief, temperature extremes are not entirely responsible for the limited use of broad-leaved evergreens in the north-central states. It is more often a lack of understanding of the soil preferences of the group, the necessary pH, and in the Heath Family* in particular the symbiotic relationship existing between certain mycorrhiza (fungi) present in acid soil and the roots of the plants. Once these important facts are recognized and heeded the other prerequisites present only minor problems in comparison.

*Members of the Heath Family (Ericaceae) all require an acid soil.

Soil

As most broad-leaved evergreens do best in a soil predominantly acid in reaction, a specially prepared mixture is necessary in limestone areas to provide a pH acceptable to them. On the "pH scale," by which soil reactions are measured, the neutral point is 7.0, with readings above denoting increasing alkalinity; those below, increasing acidity. The preferred range for the Ericaceae is between pH 4.5 and 6.0, with 5.0 representing the ideal condition. At this point the necessary iron is more readily available to the plant and the growth of beneficial mycorrhiza stimulated. We have found an ideal mixture to be one consisting of equal parts of woodland soil (top soil from oak woods), neutral sand (washed), decomposed oak leaf mold and peat moss (German or Swedish). If available, oak stump dirt (the rotted wood from stumps or fallen logs), pine needles, or decomposed



Courtesy Dogget-Pfeit

This simple automatic device can be used to acidify hard water (high in lime) so it will not make soil which has had to be especially acidified alkaline again.

McFarland

The hybrid azalea LOUISE GABLE.

oak sawdust may be substituted for the peat. Our beds test pH 5.3. Acidity may be increased artificially by the use of ordinary sulfur, applied at a rate not exceeding 1 pound per 100 square feet per application, ammonium sulfate (one tablespoonful to 10 quarts of water), or a tannic acid solution consisting of 1 part commercial tannic acid to 50 parts of water. Aluminum sulfate, commonly recommended as a soil acidifier, should (if used at all) be applied cautiously in view of the fact that its continued use may cause an aluminum toxicity harmful to both roots and mycorrhiza.

Before putting in the special soil, existing soil should be removed to a depth of 2 or $2\frac{1}{2}$ feet and the excavation lined with 6 inches of cinders. Into this goes the soil mixture described above. To lessen the amount of lime leaching in from surrounding areas it is advisable to raise the planting beds above the existing grade. The cinders will deter earthworms to a certain extent, although eventually they will tunnel into the acidified soil, depositing their castings of high lime content. During drouth periods the natural upward movement of ground moisture will also bring with it a certain amount of lime dissolved from the subsoil. These conditions may be overcome by confining the plantings to concrete or metal-lined pits provided with drainage outlets at the base. For small collections discarded oil drums sawed in half and buried to within an inch or so of ground level make excellent containers, accommodating single specimens nicely.

Buhle

Though not a shru
yucca remains gree
all winter.

Drainage

Poor drainage, sun, and wind are among the worst enemies of the Ericaceae and in selecting a suitable planting site for members of the family due consideration must be given all three. Our collection is located in a natural, wooded ravine sloping gradually in a north, northwesterly direction, where surface drainage is good and where a gravelly subsoil insures no standing water underground. None of the broad-leaved evergreens will tolerate soggy conditions even though they do prefer a constant moisture supply and high humidity.

Light

High overhead shade furnished by native oaks provides summer protection from bright sunlight and filtered light at other seasons. More winter shade would be desirable as a further protection against possible injury.

Protection

A shelterbelt of coniferous evergreens surrounding the ravine adequately meets the wind problem and may in time provide the necessary evergreen shade. In home ground plantings a shaded north or northeast exposure is desirable with further protection on the west and north. Not only will this guard against the drying effects of hot summer winds, it will lessen the chances of winter drying as well. The latter results from excessive evaporation during sunny winter days when frozen soil around the roots prevents normal replacement of the moisture lost through the leaves. Spraying the foliage in the fall with one of the new plastic sprays such as "Wiltpruf" will materially reduce evaporation, as will also a covering of evergreen branches placed over the plants.

A further word as to winter care. Although we have depended primarily on a covering of evergreen branches, plants of doubtful hardiness may be given added protection by encircling them with a ring of chicken wire filled with oak leaves. This ring should be 18 to 36 inches high depending upon the size of the plant.

Care

It is perhaps superfluous to mention that in establishing a planting of broad-leaved evergreens, only balled and burlapped stock should be used and that spring planting (April) is imperative in this region. Most Ericaceae are shallow-rooted and extremely sensitive to drying, so benefit by a heavy moisture-conserving mulch of oak leaves, pine needles, or peat moss kept on the year around. A covering of this type also serves to maintain acidity. Cultivation is unnecessary, in fact harmful. Unless rainfall is ample and well spaced, artificial watering will be necessary throughout the summer and fall. It should be done regularly and thoroughly, before drooping foliage indicates the need. Rain water is preferable where local well water has a pH above 7, but it is possible to neutralize the latter by introducing acidifying chemicals into the hose line.

Regular fertilizing with one of the standard rhododendron and azalea fertilizers in spring or early summer will help keep the plants in vigorous condition, but should iron deficiency show up in the form of yellowing foliage (chlorosis), one of the new chelated iron foliar sprays should be applied to correct the situation.

Branches of spruce or fir placed around rhododendron bush in winter give good protection, i.e., shelter from sun and drying winds.

Buhle

McFarland

Japanese box (*Buxus microphylla japonica*) in the snow.

BROAD-LEAVED EVERGREENS AT MORTON ARBORETUM, LISLE, ILLINOIS—EVALUATION OF TRIALS TO DATE

A = Prefers an acid soil
S = Satisfactory
F = Fair
P = Poor
Tr = Still on trial
* Most adaptable for trial in the Chicago area

Bearberry, *Arctostaphylos uva-ursi*	P
Wintergreen Barberry, *Berberis julianae*	F
Threespine Barberry, *Berberis triacanthophora*	P (tender)
Warty Barberry, *Berberis verruculosa*	P (tender)
Littleleaf Boxwood, *Buxus microphylla*	S
Kingsville Dwarf Boxwood, *Buxus microphylla compacta*	F
Japanese Littleleaf Boxwood, *Buxus microphylla japonica*	S
*Korean Littleleaf Boxwood, *Buxus microphylla koreana*	S
Weller's Hardy Boxwood, *Buxus sempervirens welleri*	P (year-round shade essential)
*Glossy Wintercreeper Euonymus, *Euonymus fortunei carrierei*	S
*Purpleleaf Wintercreeper Euonymus, *Euonymus fortunei colorata*	S
Large-leaved Purpleleaf Wintercreeper Euonymus, *Euonymus fortunei colorata* large-leaved	S
Baby Wintercreeper Euonymus, *Euonymus fortunei minima*	S
*Common Wintercreeper Euonymus, *Euonymus fortunei radicans*	S
Whitevein Wintercreeper Euonymus, *Euonymus fortunei reticulata*	S
*Bigleaf Wintercreeper Euonymus, *Euonymus fortunei vegeta*	S
Spreading Euonymus, *Euonymus kiautschovica* (*patens*)	F (semi-evergreen, tender)
*Baltic Ivy, *Hedera helix baltica*	S

*Bulgarian Ivy, *Hedera helix bulgaria* (Missouri Bot. Garden)	S
Roumanian Ivy, *Hedera helix roumania* (M.B.G.)	S
*Thorndale Sub-zero Ivy, *Hedera helix* THORNDALE SUB-ZERO	S
Convexleaf Japanese Holly, *Ilex crenata convexa*	A, P
Hetz Japanese Holly, *Ilex crenata hetzi*	A, Tr
Bigleaf Japanese Holly, *Ilex crenata latifolia*	A, Tr
Inkberry, *Ilex glabra*	A, F
American Holly, *Ilex opaca*	A, S
*Bosley Hedging Holly, *Ilex opaca* BOSLEY HEDGING	A, S
Old Heavy Berry Holly, *Ilex opaca* OLD HEAVY BERRY	A, Tr
Mountain Laurel, *Kalmia latifolia*	F, P
*Drooping Leucothoe, *Leucothoe catesbaei*	S
Variegated Drooping Leucothoe, *Leucothoe catesbaei* RAINBOW	Tr
Redtwig Leucothoe, *Leucothoe recurva*	S
*Oregon Holly-grape, *Mahonia aquifolium*	S
Leatherleaf Mahonia, *Mahonia beali*	A, Tr
Creeping Mahonia, *Mahonia repens*	Tr
Bayberry (semi-evergreen), *Myrica pennsylvanica*	S
*Canby Pachistima, *Pachistima canbyi*	A, S (year round shade essential)
*Japanese Spurge, *Pachysandra terminalis*	A, S
*Mountain Pieris, *Pieris floribunda*	S
*Japanese Pieris, *Pieris japonica*	S
*Carolina Rhododendron, *Rhododendron carolinianum*	S
White Carolina Rhododendron, *Rhododendron carolinianum album*	Tr
*Catawba Rhododendron, *Rhododendron catawbiense*	S
White Catawba Rhododendron, *Rhododendron catawbiense alba*	Tr
Rhododendron catawbiense hybrids:	
AMERICA	Tr
DR. DRESSELHUYS	Tr
IGNATIUS SARGENT	Tr
*PRESIDENT LINCOLN	S
Wilson Rhododendron, *Rhododendron laetevirens*	Tr
*Rosebay Rhodendron, *Rhododendron maximum*	S
Cunningham's White, *Rhododendron maximum* hybrid	Tr
Smirnow Rhododendron, *Rhododendron smirnowi*	Tr
Leatherleaf Viburnum, *Viburnum rhytidophyllum*	F (tender)
*Common Periwinkle, *Vinca minor*	S
White Periwinkle, *Vinca minor alba*	S
Purple Periwinkle, *Vinca minor atropurpurea*	S
Bart's Bigleaf Periwinkle, *Vinca minor* BARTS BIGLEAF	S
*Bowles Periwinkle, *Vinca minor* BOWLES VARIETY	S
*Adamsneedle Yucca, *Yucca filamentosa*	S

Azaleas (Evergreen)

Rhododendron amoenum (Kurume)			Tr
Rhododendron amoenum coccineum (Kurume)			Tr
Rhododendron obtusum ADDY WERY (Kurume)			Tr
Rhododendron "Gable Hybrids"			S
*ELIZABETH GABLE	S	PURPLE SPLENDOR	Tr
*HERBERT	S	ROSEBUD	Tr
*LA ROCHE		*ROYALTY	S
LOUISE GABLE	Tr	SUSAN	F

BROAD-LEAVED EVERGREENS BORDERING THE APPALACHIAN REGION

Appraisals based on observations in eastern Ohio

Paul R. Bosley

IN COLDER climates fewer kinds of broad-leaved evergreens can be grown than in warmer regions. The need of many of them for acid soil also limits the varieties which may be successfully grown.

To many people in the Eastern United States, Ohio is where the West begins. This is true to the extent that there is a line splitting the state down the middle, even down the main street of the capital city, that marks a boundary between soils characteristic of much of the West and those typical of the East.

To the east of this line are acid soils—and a paradise for broad-leaved evergreens. To the west the soils have largely a limestone base and are neutral or alkaline—cornfields stretch as far as the eye can reach across the Great Plains to the Rocky Mountains, but many of the finest broad-leaved evergreens are unable to grow at all.

So far as climate is concerned, cultural directions for growing broad-leaved ever greens in Ohio will also apply to all o Zone 5 and the warmer parts of Zone 4 But the information concerning the man acid-loving plants applies only to Pennsylvania, Virginia, and West Virginia and the eastern halves of Ohio and Kentucky.

While the rhododendrons and azalea which are the glory of spring in the north eastern section of Ohio, as well as kalmi and pieris, absolutely must have acid soi in order to live, the situation is not entirely hopeless for gardeners in the alka kine soil regions. American holly (*Ile opaca*), the forms of Japanese holly (*I crenata*), euonymus, boxwood, and ma honia all do quite well in such soils Euonymus in its various evergreen form is the "poor man's aristocrat" amon the broad-leaved evergreens. Boxwoo (*Buxus*) is not particularly at home thi far north, but there are several form

Restrained use of convex-leaved Japanese holly (*Ilex crenata convexa*).

McFarlan

that are hardy enough to be used in this area. The same is true for the evergreen ivies (*Hedera*).

Rhododendron Culture

Among the acid-lovers, rhododendrons and azaleas are the favorites. They were long considered difficult plants to grow, but now their cultural requirements are well enough understood that gardeners are assured of success. In addition to their need of acid soil, they have shallow roots which require air—therefore light, porous soil is a necessity. These plants can be grown better standing on top of the soil than in a heavy soil, even an acid one. Baled peat that has been thoroughly moistened before being dug into the garden soil provides the best way of maintaining long-time porosity.

Few gardeners realize the importance of removing the faded blooms so the entire strength of the plant may be devoted to making buds for the following year's blossoms.

Azalea and Rhododendron Varieties

If I had but one evergreen azalea to choose, it would be FEDORA; other favorites are FIREBALL, PINK BOUQUET, CARMEN, ZAMPA, and KATHLEEN. Many of the earlier Gable hybrids have been discarded, but some of the later ones are proving to be wonderful varieties. Among other things, Gable has been trying to produce new varieties of azaleas that will not set a heavy crop of seed, and thus drain the vitality of the plant and reduce its bloom the following year. Among his achievements that are worth remembering and asking for are: HERBERT, ROSE GREELY, LOUISE GABLE, JAMES GABLE, CAROL, and PINK ROSETTE.

The so-called Catawbiense hybrids are the most widely planted rhododendrons in the eastern Ohio region. CUNNINGHAM'S WHITE, perfectly hardy here, is a classic example of a fine foliage type, the demand for which has never been satisfied.

The special hardy Dexter rhododendrons that were so carefully accumulated during Mr. Dexter's lifetime, bloom so profusely as to completely envelop the plants with flowers. Plantsmen have been working to propagate these forms and it is only a matter of time until this new class of rhododendrons will be generally available to gardeners (see page 253).

American Holly

A broad-leaved evergreen that has made phenomenal strides during the last decade in reliability and popularity is the American holly (*Ilex opaca*). These hollies can be purchased as named varieties with more or less proven characteristics; many make top-rate garden plants. They withstand city conditions well and can be maintained in any form from a tightly clipped hedge that grows only an inch a year to a splendid specimen plant allowed to develop a foot a year.

Ninety-eight per cent of the American hollies growing in the wild lack good enough characteristics to warrant their use in a garden, whereas the named varieties are reproduced only from cuttings of the best plants yet discovered.

American hollies can be grown easily enough in sections of the country having alkaline soil. In such soils the iron so necessary if plants are to develop good foliage color is tied up, but the application of iron sulfate or the chelated irons will relieve the chlorosis that may develop in problem spots (see PLANTS & GARDENS, Vol. 10, No. 4, page 258).

Some varieties of American holly are proving hardy along the southern edge of Canada, in the Toronto area, as well as in Maine and northern Michigan.

The variety HEDGEHOLLY is a very distinctive form with a somewhat smaller leaf than most and a valuable self-branching habit that makes it perfect as a specimen plant and especially as a hedge.

SANTA CLAUS is one of the better male hollies, blooming so profusely as to make the flowers a feature of the plant. OLD HEAVY BERRY is a fine plant with glossy leaves approaching those of the less hardy English holly (*Ilex aquifolium*).

CHRISTMAS CAROL is a New England selection which has a narrow habit of

Grossman

Rich pink blossoms of azalea FEDORA combined with boxwood, forget-me-nots, and candytuft in a pathside planting.

growth that makes it admirable for small houses on narrow lots.

We have just recently noted that birds do not particularly like the berries of the variety YULE, so it remains pretty in the garden for a much longer time than others.

Foliage of round-leaved Japanese holly gives bolder effect than that of other varieties of Japanese holly.

University of Washington Arboretum

We have a variety (as yet unnamed), the berries of which start coloring at least two months ahead of the others, in this way extending its period of beauty. This variety is also disliked by birds, and is let completely alone by them.

The Holly Society of America has been the means of bringing together holly growers and lovers, and is promoting this fine native American plant which may well become one of the outstanding plants for American gardens.

Other Hollies

The average gardener does not think of the Oriental forms of *Ilex* as holly, but they are important broad-leaved evergreens. *Ilex crenata convexa* is being widely grown and many regard it as a more dependable plant than straight *I. crenata*. A newcomer which is very good is *I. crenata hetzi*. It has broader and more pronouncedly turned-back (convex) leaves, and is destined to be a leader in the group when better known. *Ilex crenata rotundifolia* gives bolder effects, while varieties like *stokesi* are slow-growing and dainty.

Landscape Uses

During the last decade the pendulum of popularity has swung from an exaggerated use of narrow-leaved evergreens (conifers) toward the greater use of broad-leaved varieties. Rhododendrons are useful for bold massive landscape effects; azaleas, particularly the kaempferi types, can be used for foreground and foundation plantings. Evergreen forms of euonymus make excellent covering for walls or banks. American holly can be grown as specimen plants that eventually become large trees. However, it is easily controlled by shearing and can be held at 8 to 10 feet, or severely trimmed as a formal hedge 4 to 6 feet high. The Japanese hollies make excellent hedges with billowy effects and are easy to control at 18 to 36 inches or higher. For similar but even more dainty effects of this sort, 12 to 18 inches tall, nothing is better than dwarf Japanese hollies such as *I. crenata stokesi* and *helleri*.

Grossman

Bold planting of skimmia, native rhododendron, salal, and ledum at edge of woodland.

FIFTY BROAD-LEAVED EVERGREEN TREES AND SHRUBS FOR THE PACIFIC NORTHWEST

Excluding rhododendron and camellia

Brian O. Mulligan

This is a list of fifty broad-leaved evergreen plants, ranging in size from trees to groundcovers, which can be grown in the climate of the Puget Sound region from Victoria, B. C., southwards down the coastal strip west of the Cascade range.

It comprises five trees, forty-one shrubs (of which fifteen are large, commonly reaching 12 feet or more in height), and seven ground cover plants; three of the latter are common also to the shrub list, namely, *Daphne cneorum, Euonymus fortunei* in certain forms, and *Hedera helix.*

It is most difficult to select fifty for this region, where the choice is so wide, and many excellent plants have perforce been omitted for various reasons, including camellias and rhododendrons which are dealt with elsewhere in this issue.

Such factors as hardiness, eventual size, garden value, and availability have all been taken into consideration in drawing up the list, for the benefit of those who have the good fortune to make gardens in this climatic zone; it is hoped that this may be of real assistance in making a choice of appropriate plant material. Native western plants are marked with an asterisk (*).

Branch of strawberry tree (*Arbutus unedo*).

Courtesy University of Washington Arboretum

Strawberry Tree (*Arbutus unedo*). Growing to 12 to 20 feet. Bushy shrub or small tree. Flowers and fruit in November and December. Flowers small, white, urn-shaped, in pendulous clusters; fruit red, ¾ inch in diameter, insipid. Decorative in early winter. Damaged in severe winters but usually recovering.

*__Hairy Manzanita__ (*Arctostaphylos columbiana*). Compact shrub 5 to 8 feet tall, stems hairy. Leaves oval, grey-green; flowers white or pale pink, in clusters, April to May; fruit light brown, September to October. Hard to transplant except when small.

*__Common Manzanita__ (*A. manzanita*). Shrub or tree growing 8 to 10 feet. Leaves green, larger and thicker than those of *A. columbiana,* stems and branches red-brown, smooth. Flowers pale pink, in drooping clusters, February to March; fruit red-brown. *A. patula* is similar but more compact and probably hardier, extending into Siskiyou Mountains of southern Oregon.

*__Bearberry, Kinnikinnik__ (*A. uva-ursi*). See page 181.

Darwin Barberry (*Berberis darwini*). Shrub 8 to 10 feet high. Leaves small, holly-like, spiny. Flowers orange, in pendulous racemes, April. Berries purple, August to September, taken by birds. Excellent hedge plant. Propagated by seeds, or cuttings in late summer.

Rosemary Barberry (*B. stenophylla*). Large shrub to 10 feet high and greater width. Leaves short and very narrow, spine-tipped. Produces quantities of small golden flowers on long arching branches in April. Berries small, purple-black. Many excellent seedling forms, such as *irwini, coccinea,* and *compacta,* usually smaller in size.

Threespine Barberry (*B. triacanthophora*). See page 182.

*__Point Reyes Ceanothus__ (*Ceanothus gloriosus*). Vigorous ground cover, 12 to 15 inches high. Leaves thick, elliptical, dark green, toothed. Flowers dark blue to purple, in stalkless clusters, sparsely produced in Seattle.

*Snowbrush, Mountain Balm** (*C. velutinus*). Vigorous shrub growing to 15 feet. Leaves large, oval, sticky and fragrant. Flowers white, in conspicuous clusters, May. Excellent for sunny, dry banks, but difficult to transplant. Should be grown from seeds. Very hardy.

Mexican Orange (*Choisya ternata*). Shrub 7 to 8 feet high. Leaves glossy green, trifoliate, aromatic. Flowers in clusters at ends of stems, white, 5-petalled, 1 inch wide, fragrant, in May. Should have a warm corner. Sometimes damaged in winters but seldom killed.

Rockrose hybrid (*Cistus aguilari* variety *maculatus*). Shrub of rounded form, 4 feet tall. Leaves narrow, tapering, wavy. Flowers 2 or 3 together, 3½ inches wide, white with conspicuous maroon blotch, early June. Very handsome.

Rockrose hybrid (*C.* DORIS HIBBERSON). Compact, upright shrub, 4 to 5 feet. Leaves grey-green. Flowers soft rose-pink, June, in loose heads, continuing for 4 to 5 weeks. Hybrid of *C. villosus,* raised in Victoria, B.C. All *Cistus* require sandy soil and sunny location. Propagate by cuttings, August to September.

Cotoneaster lactea. Shrub growing to 10 feet; branches spreading and arching. Leaves markedly veined, grey beneath. Flowers white, in clusters along branches; berries small, bright red, November to January. Very decorative in mid-winter.

Rockspray Cotoneaster (*C. microphylla* and varieties). Small shrubs, usually 1½ to 3 feet tall. Leaves very small, dark green, shining. Flowers usually borne singly but very freely, white, May to June. Berries red, September to October. Suitable for rock gardens.

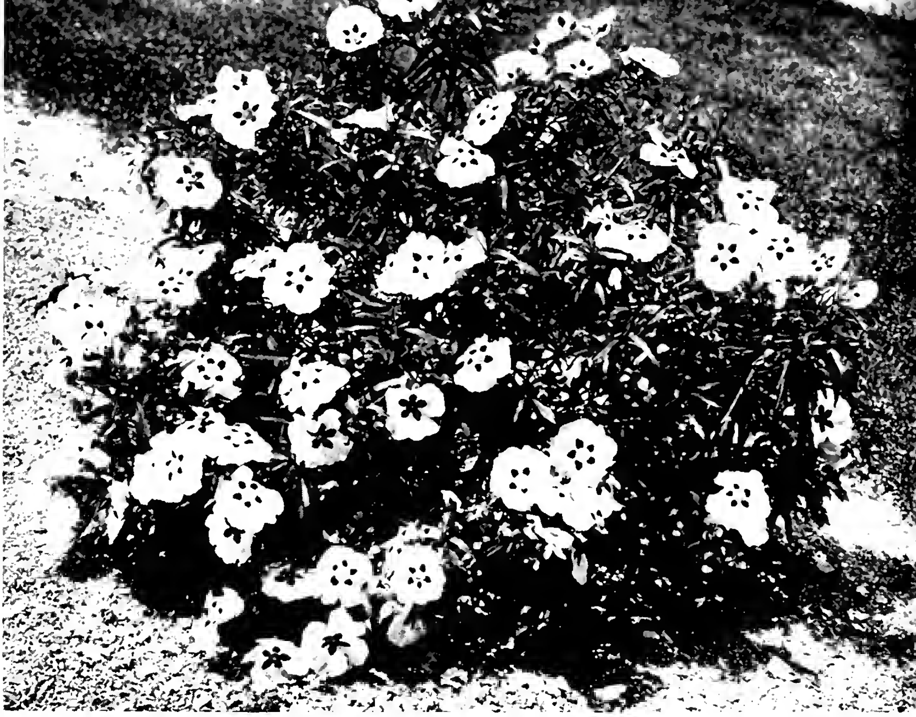
Willowleaf Cotoneaster (*C. salicifolia*). Tall, vigorous shrubs to 15 feet. Leaves narrow, conspicuously veined, usually woolly beneath. Flowers white, June, in compact clusters. Berries bright red, October. Can be trained on walls or fences.

Garland Flower (*Daphne cneorum*). See page 184.

Winter Daphne (*D. odora*). Shrub about 4 feet high. Leaves 3 to 4 inches long; flowers purple (or white), in compact small heads, very fragrant, April. Needs warm corner.

Grossman

Darwin Barberry (*Berberis darwini*).



Cistus aguilari variety *maculatus*.

Mexican orange (*Choisya ternata*).

Thorny Elaeagnus (*Elaeagnus pungens* variety *maculata*). See page 184.

Eucryphia nymansensis. Vigorous natural hybrid between Chilean *E. glutinosa* (deciduous) and *E. cordifolia* (evergreen) found in an English garden. Erect dense tree to 40 feet tall. Compound leaves. Flowers white, fragrant, 4-petalled, saucer-shaped, 2½ inches wide, August. Not too hardy when young but worth care and protection.

Winter-creeper (*Euonymus fortunei*). See page 186.

***Silk Tassel** (*Garrya elliptica*). Upright shrub, usually 8 to 10 feet tall. Leaves dark green above, grey and woolly beneath, wavy on margin. Flowers in pendent tassels, 4 to 6 inches long, grey-green, January to February; male plants more ornamental than female. Needs a sunny bank; difficult to transplant except from pots.

Miquel Wintergreen (*Gaultheria miqueliana*). Ground cover, 9 inches high, spreading by underground stems. Leaves thick, dark green. Flowers white, globular, in racemes, May. Fruit pure white, size of a pea, September to October. One of the hardiest Asiatic species.

***Salal** (*G. shallon*). Shrub 3 to 5 feet tall. Leaves about 3 inches long, shining on upper surface. Flowers in racemes, 3 to 5 inches long, small, urn-shaped, white or pinkish, May. Fruit black, globular, sweet and edible. Prefers semi-shade; spreads by underground stems.

English Ivy (*Hedera helix* varieties). See page 186.

English Holly (*Ilex aquifolium* varieties). See page 186.

Camellia-leaved Holly (*I. altaclarensis camelliaefolia*). One of the best of the hybrid hollies, with broad, glossy, dark green, almost spineless leaves. Berries large, bright red, but not freely produced on small trees.

Japanese Holly (*I. crenata convexa*). See page 188.

Long-stalk Holly (*I. pedunculosa*). Large shrub or small tree to 30 feet. Leaves spineless, oval, shining; fruit on long slender stalks, bright red, slightly smaller than English holly. Hardy and ornamental, but both sexes required for fruiting.

Salal (*Gaultheria shallon*).
Photos courtesy University of Washington Arboretum

Cascades Mahonia (*Mahonia nervosa*).

Mountain Laurel (*Kalmia latifolia*). See page 188.

Drooping Leucothoe (*Leucothoe catesbaei*). See page 190.

Japanese Privet (*Ligustrum japonicum*). Bushy shrub, usually 5 to 7 feet tall. Leaves rather thick, dark green, shining. Flowers in pyramidal clusters, white, July to August. Makes a dense hedge. Variety *rotundifolium* is slow growing, very compact, with rounded leaves.

Southern Magnolia (*Magnolia grandiflora*). Tree growing to 80 feet. The familiar evergreen magnolia with glossy leaves, flowering in summer. Flowers very large, white, fragrant, cup-shaped. Requires a warm corner or wall to flower freely. Varieties *lanceolata* (*exoniensis*), GOLIATH, and ST. MARY are superior forms.

***Oregon Grape** (*Mahonia aquifolium*). See page 188.

***Cascades Mahonia** (*M. nervosa*). Ground cover shrub for shady places, 1 to 2 feet tall. Leaves of 9 to 17 leaflets, tough, elongated, and sharply pointed. Flowers in long upright racemes, yellow, May. Fruit purple, August. Less easy to establish, but valuable.

Holly Osmanthus (*Osmanthus ilicifolius*). See page 188.

***Oregon Boxwood** (*Pachistima myrsinites*). Low, spreading shrub of 2 to 3 feet, somewhat variable in form, leaf size and shape. Usually found on dry slopes under partial shade. Leaves small, more or less oblong, slightly toothed. Flowers and fruit insignificant. Hardier than common box.

Chilean Pernettya (*Pernettya mucronata*). Shrub growing to 3 feet. Leaves small, shining, spiny-pointed. Flowers small, white, bell-shaped, very freely produced, in May. Berries varying from white to red to purple, fleshy, up to ½ inch wide. Increases by underground stems; prefers sandy soils.

Photos courtesy University of Washington Arboretum

Chilean Pernettya (*Pernettya mucronata*).

Chinese Photinia (*Photinia serrulata*). Large shrub or small tree, usually 10 to 15 feet tall. Leaves reddish when unfolding, large, shining, toothed. Flowers small, white, in broad compound heads, May to June. Fruit red, small, seldom produced here in quantity. Handsome foliage; should have a sheltered corner.

Japanese Pieris (*Pieris japonica*). See page 192.

Cherry Laurel (*Prunus laurocerasus*). Large shrub or spreading small tree to 25 feet. Various forms from different areas vary in habit, size, shape and color of foliage, and hardiness. Type used for hedges, but not satisfactory unless carefully tended. Forms from Balkans with small leaves are hardiest (varieties *schipkaensis* and *zabeliana*). Flowers white, in racemes 3 to 5 inches long in summer; fruit black. The Portugal laurel, *P. lusitanica,* is somewhat hardier, with darker foliage, and grows equally large.

Laland Firethorn (*Pyracantha coccinea lalandi*). See page 194.

Sweet Box (*Sarcococca confusa*). Compact, dense shrub, 4 to 5 feet tall. Leaves oval, long-pointed, shining on upper side. Flowers small, white, fragrant, February to March. Fruit black, October to November. Shade-loving and will grow well on heavy soils. Valuable also for early, fragrant flowers. Frequently misnamed *S. ruscifolia,* which has red fruits.

Senecio laxifolius. Somewhat loose and spreading in form, 3 to 4 feet tall. Stems and leaves whitish downy when young, the latter especially so beneath. Flowers bright golden-yellow in loose clusters, June to July. Useful in foundation planting; tolerates considerable sun and wind. Commonly and wrongly named *S. greyi.*

Reeves Skimmia (*Skimmia reevesiana*). Low, spreading shrub, 1½ to 2 feet tall. Leaves narrow, long-pointed, dark green on upper side. Flowers in short clusters, white, fragrant, in May. Fruit dark red, oval or pear-shaped, October to April.

University of Washington Arboretum

Sweet Box (*Sarcococca confusa*)

Buhle

Long-stalk Holly (*Ilex pedunculosa*)

S. foremanii and variety *rogersi* are hybrids with *S. japonica*, preferred to it for garden use.

Chinese Stranvaesia (*Stranvaesia davidiana*). Tall shrub, 15 to 20 feet high. Leaves narrowly oblong, 3 to 4 inches long. Flowers in compound heads, small, white with red anthers, June. Fruit round, ¼ inch wide, red, October to November. Variety *undulata* is much lower and more spreading in habit with smaller leaves, wavy along the margin.

***California Bay** or **Laurel; Oregon Myrtle** (*Umbellularia californica*). Tree 50 to 60 feet tall in the wild, smaller in cultivation in Northwest. Leaves oblong, 3 to 4 inches long, glossy above, strongly aromatic when crushed. Flowers small, creamy-yellow, in leaf axils, March to April. Fruit rounded, 1 inch long, plum-like, green becoming purple. Similar in appearance to bay tree (*Laurus nobilis*) but much hardier.

***Evergreen Huckleberry** (*Vaccinium ovatum*). Shrub 6 to 8 feet high. Young shoots purplish. Leaves small, ovate, thick, glossy on upper surface. Flowers in short clusters, small, bell-shaped, pink, May. Fruit globose, black or glaucous, edible, October. Attractive at all seasons. Likes partial shade.

David Viburnum (*Viburnum davidi*). Low, compact shrub, 3 to 4 feet high. Leaves 4 to 5 inches long, three-veined, dark green on upper surface. Flowers very small, densely crowded in heads, white, June; male and female on different plants. Fruit (on latter) small, oval, steel-blue, September to October. Especially valuable for fruit if both sexes are planted.

Sweet Viburnum (*V. odoratissimum*). Tall, upright shrub, 15 to 20 feet high. Leaves large, oval to oblong, 5 to 8 inches long, thick, glossy green on upper surface. Flowers small, in open clusters, seldom produced in Northwest. A very handsome foliage shrub, deserving a warm corner.

Laurestinus (*V. tinus*). Dense, more or less upright shrub, 7 to 10 feet tall. Leaves oval, 2 to 4 inches long, dark green on upper surface (shining in variety *lucidum*). Flowers small, white, in compact heads, 3 to 4 inches wide, December to April, according to variety and climate. Fruit very small, dark blue, seldom produced in quantity. Stands city conditions well.

BROAD-LEAVED EVERGREENS IN THE SOUTH

Kinds to use, how to grow them, and suggestions for landscape use

James J. Franklin

MUCH of the charm of the Deep South is found in its spreading live oaks, bright flowered winter-blooming camellias and azaleas, trim, symmetrical boxwood hedges, and its magnolias with plate-sized fragrant blossoms. All of these, and more, are broad-leaved evergreens. In fact, a large proportion of the plants used in landscaping throughout the Gulf and southern Atlantic states are broad-leaved evergreens. Ten of the leading nursery firms of the area list over 150 kinds.

In the camellia growing areas there is at least one gardener in every town who has a planting of 50 to 100 varieties of camellias; some enthusiasts grow several hundred different varieties. Likewise, home azalea plantings frequently contain 10 to 20 varieties.

Reason for Success

The widespread use of broad-leaved evergreens throughout this mild-winter region is partly due to the rare occurrence or total absence of very low temperatures combined with drying winds, a combination that generally spells trouble for broad-leaved evergreens. Shallow root systems such as many broad-leaved evergreens possess freeze easily. If wind or sun cause loss of water from the leaves while the roots are in this condition, winterburn results. Conditions causing winterburn are rare in most of the South.

Other reasons for the success southern gardeners have with broad-leaved evergreens are the moist climate with rainfall rather evenly distributed throughout the year, and soils that are for the most part slightly acid.

Soil and Light

The native broad-leaved evergreens of the region are not found everywhere. They grow chiefly under a partial cover of deciduous trees in moist but well-drained soils containing a large propor-

Flowers and leaves of laurestinus (*Viburnum tinus*).

Fruit of laurestinus.
University of Washington Arboretum

Large leaves and huge white flowers of southern magnolia make it one of the most impressive of ornamental trees.

Hedge of yaupon (*Ilex vomitoria*).

tion of leaf mold. When attempting to grow such plants on properties from which the trees have long since been removed, it is usually necessary to add organic matter such as leaf mold or peat moss to the soil. Where soils are heavy (clay) it is advisable to add sand as well as organic matter to lighten them, especially for azaleas, rhododendrons, and camellias. It is not always necessary to supply the partial shade found in most natural environments of broad-leaved evergreens. Mature plants of many species do fully as well in full sun, and frequently flower or fruit more freely than in shade.

Tolerant Kinds

Further extending the use of broad-leaved evergreens in the South is the rather large group that also succeeds under neutral or slightly alkaline soil conditions, such as euonymus, ivy, jasmine, abelia, barberry, most hollies, privet, firethorn, most viburnums, and yucca. Some, such as privets, spreading euonymus, primrose jasmine, laurestinus viburnum, carolina bayberry, firethorns, and elaeagnus, can thrive in dry situations; while inkberry, coast leucothoe, rosebay rhododendron, mountain laurel, common oleander, sweet-bay magnolia, and live oak succeed in swampy or boggy places.

Transplanting

In the Upper South (Zone 7 and north) where the soil freezes at times in winter, broad-leaved evergreens are best transplanted in the spring. It is possible to move them in the fall if it can be done early enough that they are partially established before cold weather sets in, and if they are given temporary protection from winter sun and wind.

Near the Gulf of Mexico and in the coastal regions of the South Atlantic States, transplanting may be safely done at any time from fall to spring. Plants that are less than 3 years old generally survive transplanting best and make maximum growth afterward when planted in partial shade and mulched.

Fertilizing

It is most important to the success of a new planting that it be in the proper location in respect to soil type and sunlight. Lacking this, proper preparation of a less suitable area to make it approach the ideal is necessary. Once broad-leaved evergreens are established in landscape plantings, they need only modest fertilization unless rapid growth is desired.

When preparing a new bed area for broad-leaved evergreens it is advisable to insure ample phosphorus for the first year's growth by incorporating superphosphate into the soil at the rate of 5 pounds for each 100 square feet of bed area. As this goes into the soil very slowly from a surface application, it should be worked into the soil to a depth of 8 to 12 inches.

Plants which have become established after a fall or winter planting can be fertilized 2 to 3 weeks before new growth begins in the spring. Or a split application can be made—half before growth in spring and half after flowering. For some plants such as camellias in which bud development and new growth occur at the same time, the second application might be best in mid-summer. But fertilizers containing readily available nitrogen are not safely applied between the middle of August and early spring, as they may encourage new growth at a time when cold spells will kill it back.

As to fertilizers: cottonseed meal or soybean meal applied at the rate of 5 pounds per 100 square feet are ideal for small plants. For large plants a 5-10-5, or other complete fertilizer with similar formula may be applied at the rate of 2 to 4 pounds per 100 square feet. These complete fertilizers are safer and more satisfactory if from 1/4 to 1/3 of their nitrogen content is derived from cottonseed or soybean meal. To fertilize individual plants, use 2 to 3 ounces of the fertilizer for a shrub with a spread of 3 feet. For trees apply at the rate of 2 to 3 pounds for each inch diameter of the trunk.

How often fertilizer is applied depends on the kind of plant and the growth response desired. Heavily flowering and fruiting plants may need to be fertilized annually, if quality is to be maintained, but others may not need to be fertilized oftener than every 3 to 5 years. A mulch 1½ to 2 inches deep should be maintained, however.

Pest Control

Lace bug is a more serious pest in the South than in the North, because of the longer breeding period. It attacks many broad-leaved evergreens. In some areas it is largely responsible for the failure of cotoneasters. Firethorn foliage is sometimes completely discolored by the end of the season, although the crop of berries does not seem to be reduced. The foliage of azaleas and rhododendrons should be carefully inspected periodically, as lace bug can spoil its appearance in a short time.

Spreading euonymus (*Euonymus kiautschovica*) can be grown as far north as New York City.

McFarland Photos

Courtesy Wight Nurseries

SUWANEE RIVER, new hybrid of *Ligustrum japonicum*, is hardy as far north as New York City.

Wild black cherry (*Prunus serotina*) is a host of lace bug, so it should be eliminated from the vicinity of plantings of broad-leaved evergreens or included in a well-timed lace bug spray program.

Note on Propagation

In the lower South where there is no freezing and heaving of the soil, hardwood cuttings (with leaves) of a number of broad-leaved evergreens can be lined-out in open, partially shaded beds in midwinter and successfully rooted. Boxwood, jasmine, firethorn, and barberry are a few which can be increased in this way.

Rate of Growth

In the coastal areas in Zone 9 vegetative growth in one season is frequently two or three times greater than it is in areas which are drier or have shorter seasons. It is well to remember this when spacing plant material for landscape plantings along the coast. If it is neglected, frequent pruning and even removal of crowded plants may be necessary.

Landscape Value

Where broad-leaved evergreens thrive they are naturally the "kings" of the plantings. In addition to their special contribution of year-around foliage, they are often productive of handsome flowers and ornamental fruit. Broad-leaved evergreens are varied in size and in form, have a wide range of growth rate from very slow to moderately rapid, and present many different foliage colors and textures.

For hedges and screen plantings broad-leaved evergreens are unsurpassed, and as foundation plants they are graceful and blend well with architectural materials and with other plants. Some of them are excellent as specimen plants, others in groups or borders. Not to be overlooked are the valuable evergreen vines.

Of the more than 150 species of broad-leaved evergreens commonly used in the South, the following lists contain some of the best, grouped according to their special uses in landscape planting.

LANDSCAPE USES OF BROAD-LEAVED EVERGREENS IN THE SOUTH

Hardier plants are indicated by a number showing to what zone north they can be grown, so lists can be used for landscape suggestions by gardeners outside the South.

Outstanding Flowers

Glossy Abelia (5) (*Abelia grandiflora*)
Scarlet Bottlebrush (*Callistemon coccinea*)
Camellias (5) (*Camellia japonica* and *C. sasanqua*)
Gardenia (*Gardenia jasminoides*)
Carolina Jessamine (vine) (*Gelsemium sempervirens*)
Jasmines (*Jasminum* spp.)
Mountain Laurel (4) (*Kalmia latifolia*)
Southern Magnolia (tree) (*Magnolia grandiflora*)
Sweetbay (tree) (5) (*Magnolia virginiana*)
Banana Shrub (*Michelia fuscata*)
Oleander (*Nerium oleander*)
Sweet Osmanthus (*Osmanthus fragrans*)
Japanese Photinia (*Photinia glabra*)
Chinese Photinia (*Photinia serrulata*)
Pittosporum (*Pittosporum* spp.)
Laurel Cherry (6) (*Prunus laurocerasus*)
Yeddo Raphiolepis (*Raphiolepis umbellata*)
Rhododendrons, in South for high altitudes only (3-4) (*Rhododendron spp.*)
Indica Azaleas (Hybrids of *Rhododendron indicum, R. simsi*, and others)
Kurume Azaleas (5) (*Rhododendron obtusum* hybrids)
Laurestinus (*Viburnum tinus*)
Bigleaf Periwinkle (ground cover) (*Vinca major*)

Outstanding Fruit

Thorny Elaeagnus (*Elaeagnus pungens*)
Spreading Euonymus (6) (*Euonymus kiautschovicus*)
Burford Chinese Holly (5) (*Ilex cornuta burfordi*)
American Holly (tree) (5) (*Ilex opaca*)
Yaupon Holly (*Ilex vomitoria*)
Southern Magnolia (tree) (*Magnolia grandiflora*)
Sweetbay (tree) (*Magnolia virginiana*)
Leatherleaf Mahonia (6) (*M. bealei*)
Partridgeberry (ground cover) (3) (*Mitchella repens*)
Southern Wax-myrtle (*Myrica cerifera*)
Nandina (*Nandina domestica*)
Chinese Photinia (*Photinia serrulata*)
Firethorns (6) (*Pyracantha* spp.)

Good for Hedges

Roundleaf Japanese Holly (5) (*Ilex crenata convexa*)
Yaupon (*Ilex vomitoria*)
Japanese Privet (*Ligustrum japonicum*)
Chinese Privet (*Ligustrum sinense*)
Laurel Cherry (6) (*Prunus laurocerasus*)

Screen Plantings

Thorny Elaeagnus (trained) (*Elaeagnus pungens*)
English Ivy (trained) (5) (*Hedera helix*)
Yaupon (*Ilex vomitoria*)
Devilwood Osmanthus (*O. americanus*)
Chinese Photinia (*Photinia serrulata*)
Laurel Cherry (6) (*Prunus laurocerasus*)

Doorway and Wall Plantings about Buildings

Aucubas (*Aucuba* spp.)
Barberries (5) (*Berberis* spp.)
Boxwoods (5) (*Buxus* spp.)
Camellias (5) (*Camellia japonica* and *C. sasanqua*)
Spreading Euonymus (6) (*Euonymus kiautschovica*)
Showy Jasmine (*Jasminum floridum*)
Mahonias (6) (*Mahonia* spp.)
Nandina (*Nandina domestica*)
Yeddo Raphiolepis (*R. umbellata*)

Specimen Trees

American Holly (5) (*Ilex opaca*)
Southern Magnolia (*M. grandiflora*)
Live Oak (*Quercus virginiana*)

Vines (on bricks and stone)

Climbing Fig (*Ficus pumila*)
English Ivy (5) (*Hedera helix*)

To Train

Carolina Jessamine (*Gelsemium sempervirens*)
Laurel Greenbriar (*Smilax laurifolia*)

University of Washington Arboretum
Arching sprays of *Cotoneaster lactea.*

BROAD-LEAVED EVERGREENS FOR SOUTHERN CALIFORNIA

and similar semitropical regions

George H. Spalding and Donald P. Woolley

Palms

Mediterranean Palm (*Chamaerops humilis*)
Canary Date (*Phoenix canariensis*)
Senegal Date (*Phoenix reclinata*)
Fortune's Windmill Palm (*Trachycarpus fortunei*)
California Washington Palm (*Washingtonia filifera*)
Mexican Washington Palm (*Washingtonia robusta*)

Trees

*Weeping Boree Acacia (*Acacia pendula*)
*Coutamundra-wattle Acacia (*Acacia baileyana*)
(There are too many species of Acacia valuable as ornamentals to be listed here.)
*Carob (*Ceratonia siliqua*)
Rusty Gum-myrtle (*Angophora lanceolata*)
*Camphor Tree (*Cinnamomum camphora*)
Citrus varieties
Loquat (*Eriobotrya japonica*)
Eucalyptus, many species including
Lemon Eucalyptus (*Eucalyptus citriodora*)
Scarlet Eucalyptus (*Eucalyptus ficifolia*)
Coolgardie Coral Eucalyptus (*Eucalyptus torquata*)
Morton Bay Fig (*Ficus macrophylla*)
**India-laurel Fig (*Ficus nitida*)
Sweetshade (*Hymenosporum flavum*)
Chinese Fan Palm (*Livistona chinensis*)

Southern Magnolia (*Magnolia grandiflora*)
Chile Mayten (*Maytenus boaria*)
Irontree (*Metrosideros tomentosa*)
Olive (*Olea europaea*)
Diamondleaf Pittosporum (*Pittosporum rhombifolium*)
*Orange-berry Pittosporum (*Pittosporum undulatum*)
Carolina Laurel-cherry (*Prunus caroliniana*)
Holly Oak (*Quercus ilex*)
*California Pepper Tree (*Schinus molle*)
Brazil Pepper Tree (*Schinus terebinthifolius*)

Shrubs

Glossy Abelia (*Abelia grandiflora*)
*Broadleaf Acacia (*Acacia latifolia*)
*Strawberry Tree (*Arbutus unedo*)
Japanese Aucuba (*Aucuba japonica*)
Azalea—Indica hybrids
Camellias—in variety
**Natal Plum (*Carissa grandiflora*)
*Ceanothus (*Ceanothus* spp.)
Rockroses (*Cistus* spp. — particularly *ladaniferus*, *laurifolius*, and *purpureus*)
Cotoneaster lactea (*Parneyi*)
**Dombeya (*Dombeya dregeana*)
Montevideo Escallonia (*Escallonia montevidensis*)
*Seaurchin Hakea (*Hakea laurina*)
Burford Chinese Holly (*Ilex cornuta burfordi*)
Laurel, Bay (*Laurus nobilis*)
Glossy Privet (*Ligustrum lucidum*)
True Myrtle (*Myrtus communis*)
*Oleander (*Nerium oleander*)
Sweet Osmanthus (*Osmanthus fragrans*)
Chinese Photinia (*Photinia serrulata*)
Tobira Pittosporum (*Pittosporum tobira*)
*Firethorn (*Pyracantha* hort. varieties)
Roundleaf Yeddo Raphiolepis (*Raphiolepis umbellata ovata*)
Japanese Viburnum (*Viburnum japonicum*)
Sandankwa Viburnum (*Viburnum suspensum*)

*Withstands drought better than others.
**May be slightly damaged by frost in colder areas.

All Year Club of Southern California
Mexican Washington palm (*Washingtonia robusta*).

McFarland

Low-growing rose daphne (*Daphne cneorum*) makes unusual evergreen edging for walk.

BROAD-LEAVED EVERGREENS IN THE UPPER MIDWEST

Even where low winter temperatures are the rule, some kinds can be grown

Leon C. Snyder

Exposed prairie conditions of the central "just-below-Canada" states are known not to be favorable to the growing of broad-leaved evergreens. Nonetheless, a measure of success can be expected if plants are grown in semi-wooded areas in medium acid soils. (For creating acid soils in the Middle West, see p. 199.)

The insulating snow cover, usually present from Thanskgiving to April, helps insure the winter welfare of broad-leaved evergreens in this region. Temperatures of —20° to —50°F. may have little or no damaging effect on snow-covered plants of recognized hardiness. Occasionally, when snowfall is early, the ground beneath does not freeze at all!

Protection from winter sun and wind is of major importance to the success of broad-leaved evergreens in this region. One way of achieving this protection is by planting in the shade of coniferous trees. Planting on the east side of buildings or in locations of dependable snow cover will also decrease the hazard of winter injury.

One clue to what will succeed in a region comes from the native plants already growing there. For example, in this north country the following broad-leaved evergreen species may be found in the wild:

Bearberry (*Arctostaphylos uva-ursi*)
Labrador-Tea (*Ledum groenlandicum*)
Bog Kalmia (*Kalmia polifolia*)

Other broad-leaved evergreens known to be hardy (or reasonably hardy) are listed as follows:

Hardy

Korean Box (*Buxus microphylla* var. *koreana*)

A variety of Dwarf Euonymus (*Euonymus nana* var. *turkestanica*)

Pachistima (*Pachistima canbyi*)

Hardy With Winter Shade and Good Snow Cover

Garland-flower (*Daphne cneorum*)

Japanese Spurge (*Pachysandra terminalis*)

Mountain Laurel (*Kalmia latifolia*)

Drooping Leucothoe (*Leucothoe catesbaei*)

Oregon-grape (*Mahonia aquifolium*)
Catawba Rhododendron (*Rhododendron catawbiense*)
Rosebay Rhododendron (*Rhododendron maximum*)

Tried But Not Dependable

Japanese Holly (*Ilex crenata*)
Persists under snow cover only. As hardy as any of the hollies.

Inkberry (*Ilex glabra*)
Kills to snow-line, but sprouts from base.

American Holly (*Ilex opaca*)
Killed second year in a recent trial.

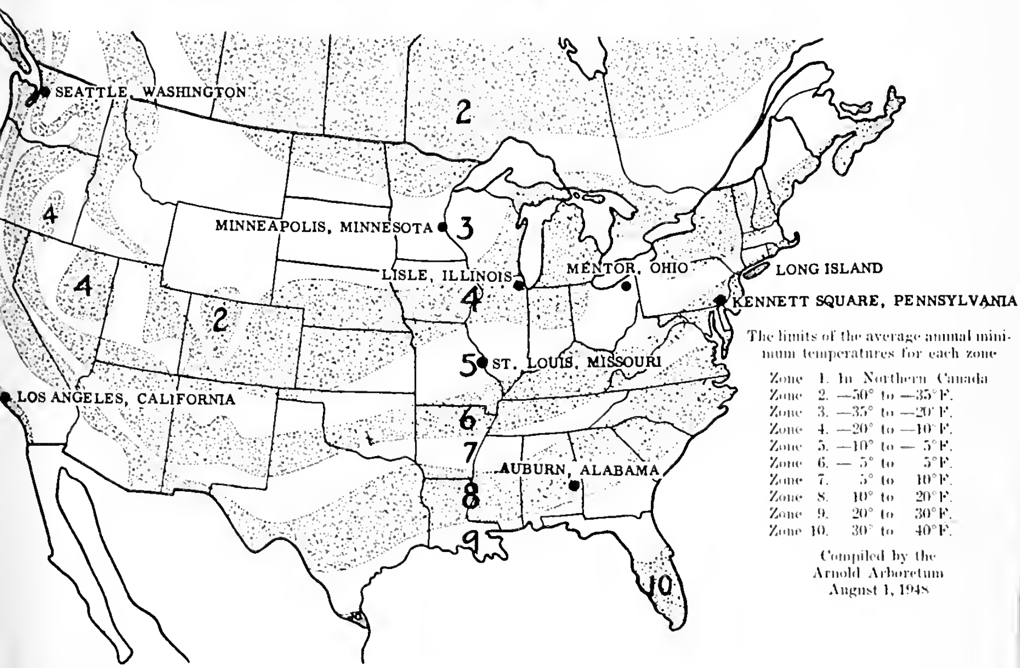
Laland Firethorn (*Pyracantha coccinea* var. *lalandi*)
Kills back to some extent but will flower and fruit when planted on east side of building.

Buhle

Bog kalmia (*Kalmia polifolia*), northern relative of mountain laurel, is useful in mixed shrub plantings.

MAP SHOWING HARDINESS ZONES

The broad-leaved evergreens included in this handbook were evaluated by authors working at nine different places in the United States (dots and names).



LANDSCAPE USES OF BROAD-LEAVED EVERGREENS

Suggestions based on experiences in the Pacific Northwest

Otto E. Holmdahl

IN our mild and moist climate that grows nearly everything lavishly and seemingly effortlessly, together with a natural scenery as beautiful and diversified as any in the world, it is not surprising that we favor an informal, naturalistic style in our landscape design and gardens. We do our plantings in such a way that the trees and shrubs are allowed to develop as they do in nature, and our plant material, not the gardener's pruning shears, controls the design in the vertical plane.

All through the gardens in the residential parts of our cities and towns are to be found large trees of madrona, dogwood, maple, and oak, not to mention the cedars, hemlocks, and firs that were already here and were carefully preserved when the subdivisions were laid out. And just beyond are large tracts of land in the natural state.

Our soils are predominantly acid and so are just right for many evergreen and deciduous shrubs and trees and of course especially so for ericaceous (Heath Family) plants.

Rhododendrons

Of all the broad-leaved evergreens the rhododendrons are, no doubt, the most important, partly because of the tremendous number of species and hybrids and partly because of the differences in their form, size, and general appearance. As there are rhododendrons of nearly every color of the rainbow it is no wonder that we use them profusely in our gardens.

Other broad-leaved evergreens are planted in places where rhododendrons do not thrive—in windy, exposed, sunny, or damp locations, and where a difference in form or leaf texture is desired. Nearly all broad-leaved evergreens need deciduous trees and shrubs to soften and give shade, grace, and airiness to an otherwise rather heavy planting. We take care, however, not to plant surface feeders that in any way interfere with the growth of the rhododendrons, such as maple, (*Acer*), poplar (*Populus*), willow (*Salix*), birch (*Betula*), cherry (*Prunus*), privet (*Ligustrum*), honeysuckle (*Lonicera*), and lilac (*Syringa*).

We like to spread our blooming season over a long period of time so that from early spring to late summer there is always color in the garden. After the flowering time is over the brilliant autumn colorings of the leaves of the deciduous trees and shrubs carry on.

In our rhododendron plantings we nearly always use some deciduous azaleas as fillers for an immediate effect. With their radiant clusters of blooms and the tender green of their new leaves they seem to create a feeling of spring that is impossible to achieve with rhododendrons alone. Later on as the rhododendrons mature some of these azaleas may have to be shifted.

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Richard Averill Smith

Broad grass path bordered with sweetbay magnolia (*Magnolia virginiana*).

Mixed Plantings

As examples of rather good combinations of rhododendrons intermixed with deciduous azaleas I would suggest a drift of *R. augustini* with *R. luteum* or pale yellow *R. mollis*, as they bloom at the same time; or *R. rubiginosum* and *R. yunnanense* with *R. occidentale* and *R. vaseyi*. Another combination might be BUTTERFLY, LADY PRIMROSE and UNIQUE with Schlippenbach's azalea (*R. schlippenbachi*)—the pale yellow of the rhododendrons is very effective against the pale pink of the azaleas.

For the rock garden or a low foreground planting the rhodendrons of the *Lapponicum* series are ideal, but the solid lavender and purple can be broken up with the pinks or pale yellows of rhododendrons such as *R. keiskei*, *R. glaucophyllum* (*glaucum*), *R. tephropeplum* and *R. pemakoense*.

Mountain laurel (*Kalmia latifolia*) is a favorite here and is often planted in drifts in the foreground of some of the small-leaved rhododendrons, such as *R. cinnabarinum* and *R. rubiginosum*, intermixed with species of pieris. Or India-hawthorn (*Raphiolepis indica*) may be used in the immediate foreground because it hugs the ground.

Eucryphias grow well here but were severely hurt by last year's freeze. *Eucryphia nymansensis* and *E. glutinosa* (*pinnatifolia*) are very good as an accent against the house where a columnar effect is desired, and planted among rhododendrons, *E. intermedia* with its transparent laciness is of great value.

Grossman photos

Fine old boxwoods and southern magnolia combined in corner planting.

Camellias

Of course *Camellia japonica* and *C. sasanqua* are used everywhere here but many of them were killed by the same freeze last November, even though some of them were planted 50 years ago. Personally I only use camellias espaliered against buildings and walls, where they make an excellent evergreen tracery that does not cover completely as ivy does. I do not like to use them on a south exposure because the wind and rain fade the flowers very quickly. Espaliered in a place where the sunlight never reaches the camellia it will produce many flowers and the foliage will be magnificent.

Other Broad-leaved Evergreens

Impervious to wind and weather, *Ilex aquifolium* in all its varieties is an excellent evergreen background to hide ugly and unsightly places. Planted with other species of *Ilex* and *Osmanthus* and perhaps with a foreground of *Mahonia aquifolium* it makes a rather stunning effect. With all the different variations of leaf color, and the different sizes and colors of the berries of the holly any number of lovely combinations can be made.

Few plants are as popular as *Daphne odora,* no doubt due to its beautiful foliage and delicate flowers with their wonderful fragrance, and nowhere does it grow any better than here. Hardly a foundation planting around a home but there is at least one *D. odora.* The variety SOMERSET and *D. cneorum* are, of course, quite necessary in the rock garden.

The photinias are much appreciated in our planting design and the new leaves give a lot of color in the early spring. *Photinia serrulata* does best here in a heavy clay soil, growing to a height of 20 feet, and is of value as a screen planting. It blooms but does not fruit with us. *P. glabra* is smaller in every way but the brilliant red of the early leaves enhances any planting.

Viburnum tinus, V. odoratissimum, and *V. burkwoodi* are the only evergreen viburnums we employ. We find them tremendously useful. The blossoms of *V. tinus* appear all through the winter and

This mass planting adjacent to open terrace includes osmanthus, azaleas, and boxwood (with edging of forget-me-nots, candytuft, and pinks).

early spring, then *V. burkwoodi* takes over and blooms for another month or two. *V. odoratissimum* does not bloom here at all but we use it for the exquisite foliage.

We have grown *Magnolia grandiflora* for many, many years, but the freeze of last year evidently killed nearly every one of these trees. As this is the first time they have ever been seriously injured, we will start with new stock brought in from the south since it is really so very necessary in the landscape design. *M. virginiana* fared much better and while it is not as showy, its slender beauty lends grace to a planting and we can use it in damp places where few other broad-leaved evergreens thrive.

As wall coverings, the firethorns (*Pyracantha*) are used practically everywhere, and lately so many new varieties have been introduced with berries of different hues that their popularity has increased. But without intelligent and proper pruning they certainly very soon grow out of bounds.

For a screen planting that does not require very much care, the different species and varieties of *Escallonia* are excellent and should be given consideration in any planting list.

In dry, exposed areas or in rock gardens that are not subject to collectors of rare plants, the rockrose (*Cistus*) species are very valuable. They produce an abundance of color and fragrance during a greater part of the summer and generally do not suffer from our wet winters.

Though perhaps the heathers (*Calluna*) and heaths (*Erica*), strictly speaking, are not broad-leaved evergreens, in an article of this kind they should be mentioned, especially as we like them very much and use them extensively in our plantings. The species and their hybrids flower at altogether different times of the year and they also have distinctive foliage colors of brown and yellow besides the green. With their abundance of blooms in white, pink, purple, and red all through winter, summer, and until late autumn, they seem very necessary in our gardens.

Grossman

Pieris japonica and dwarf rhododendron FABIA used with restraint in entrance planting.

Imaginative use of firethorn produced by training on wire and selective pruning.

Variegated winter-creeper (*Euonymus fortunei*) presents cheerful sight in winter.

Grossman

McFarland

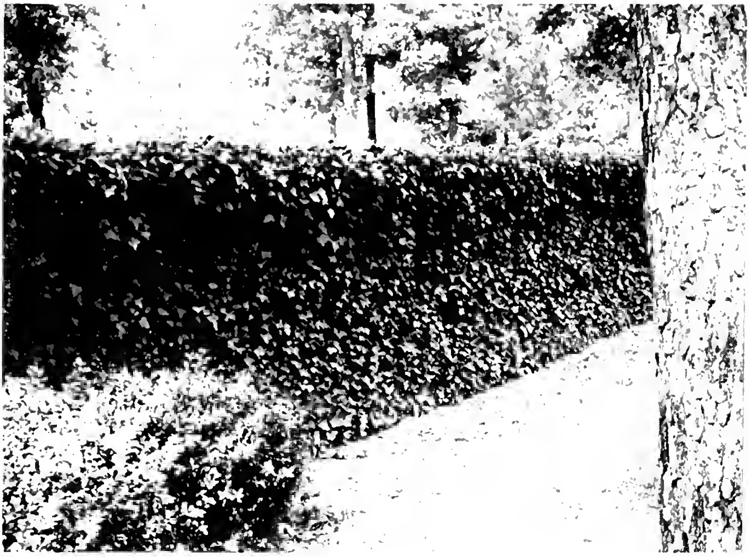
Wintercreeper (*Euonymus fortunei colorata*) makes fine ground cover, here used on bank.

Formal and informal uses of convex-leaved Japanese holly (*Ilex crenata convexa*). When clipped, as below, this variety makes a firm, fine-textured hedge.

Roche

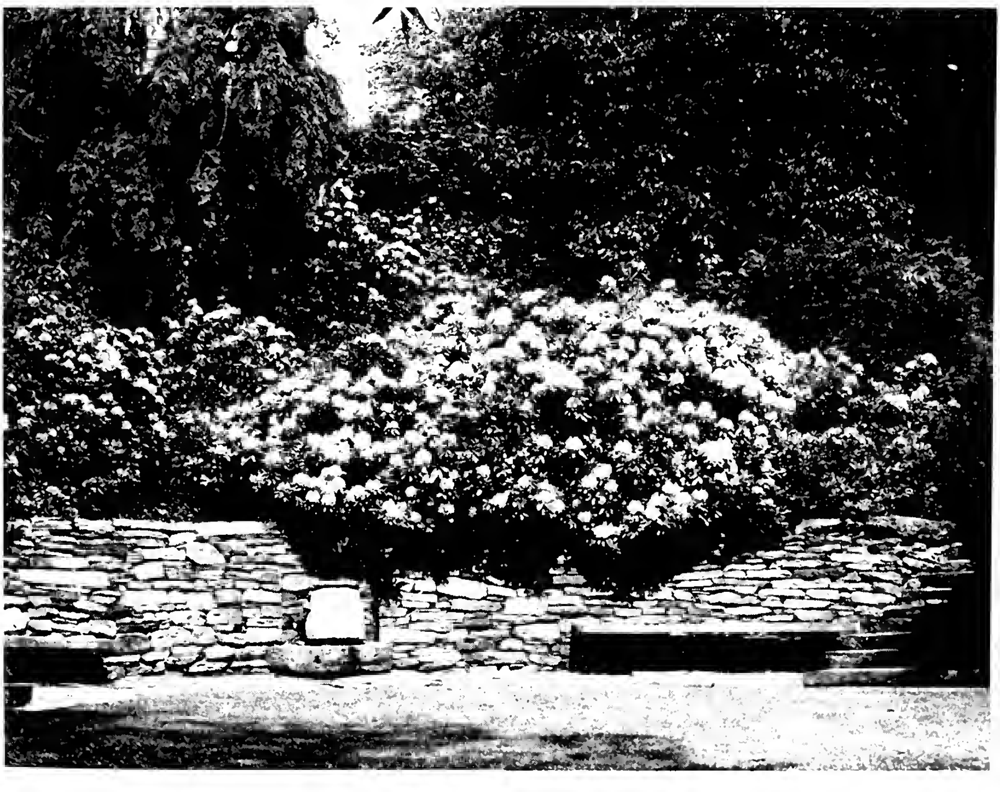
Richard Averill Smith

A chain link fence may be completely obscured by English ivy, giving a hedgelike effect.



Unusual landscape effect is created by rhododendron overhanging stone wall. Precaution: In such a location, plants when young should be set well back from wall, and always adequately watered.

Frese photos



DWARF BROAD-LEAVED EVERGREENS FOR THE ROCK GARDEN

. . . and some can be used as borders, low hedges, or ground covers

Alys Sutcliffe

Several broad-leaved evergreens are very suitable additions to the rock garden. In spring and summer their foliage serves as a foil for other plants, and in winter the green or bronze leaves brighten an otherwise dead-looking garden and remind us that there is life there, even in the dormant season. Some of these dwarf broad-leaved evergreens pay extra dividends of attractive flowers.

Many of the plants listed below, like their larger counterparts, prefer or even demand acid soil. For gardeners whose soil is neutral or slightly alkaline, the varieties of Japanese holly, barberry, honeysuckle, box, and teucrium are recommended.

In the Pacific Northwest grow many dwarf rhododendrons which are suitable for the rock garden. The ones listed here have proved hardy in the East, and are worth trying at least as far north as Cape Cod.

Rarely thought of as broad-leaved evergreens are a number of plants native to the northeastern states. They include some of the most attractive specimens for the small shady rock garden, or a shady corner of a large garden. All are hardy, even in northernmost states, and add a welcome touch of green to the winter woods.

Two of the best known are trailing arbutus (*Epigaea repens*) and partridgeberry (*Mitchella repens*). Similar in its trailing habit, but perhaps not so well known, is creeping snowberry (*Chiogenes hispidula*). These will grow best in well drained woodland soil and need some shade. Another trailing evergreen which is very useful for sandy soil and rocky places in full sun is bearberry or kinnikinnik (*Arctostaphylos uva-ursi*). Alpine-azalea (*Loiseleuria proeumbens*) is a truly northern plant which grows into

Littleleaf boxwood (*Buxus microphylla compacta* var. KINGSVILLE) in rock garden.

Newfoundland and northward. A low-growing horticultural form of pale laurel (*Kalmia polifolia* var. *nana*) is suitable to rock gardens. Another truly dwarf form of this, *Kalmia polifolia* var. *microphylla,* is native to the high mountains of Colorado, but given the right conditions can be persuaded to grow elsewhere.

Three other native American plants which can be included in this group are pipsissewa (*Chimaphila maculata*), Oconee bells (*Shortia galacifolia*), and galax (*Galax aphylla*). While not perhaps strictly woody plants, the creeping rootstocks of these are woody, and their evergreen leaves give them a place as broad-leaved evergreens.

Many of these natives are very difficult to transplant from the wild. It has been found that much better success is had if plants are obtained from nurserymen who specialize in growing them. For this reason, and to conserve these plants in their native habitats, it is recommended that they be purchased, not dug up from the woods.

McFarland pho

Germander (*Teucrium chamaedrys*) is splendid in many situations, including low hedges and border plantings.

LIST OF DWARF BROAD-LEAVED EVERGREENS

Bearberry (*Arctostaphylos uva-ursi*)
Trailing, likes full sun, will grow in sandy soil. White or pinkish flowers in spring. Excellent ground cover.

Barberry (*Berberis*)
Two species suitable for rock gardens. *B. candidula* is a dwarf shrub with leaves to 1¼ inches long, white beneath. *B. verruculosa* grows to 3 feet, has glossy dark green, spiny-toothed leaves and small yellow flowers.

Boxwood (*Buxus*) See page 235.
Two varieties are good for rock garden use. *Buxus microphylla koreana* grows to 2 feet, has open upright growth, while *B. microphylla compacta* var. Kingsville forms a compact mound somewhat like *Ilex crenata helleri* but with bright green shiny leaves.

Pipsissewa (*Chimaphila*)
Two species, *C. maculata* and *C. umbellata cisatlantica*, grow to about 10 inches. *C. maculata* has leaves with shiny teeth, variegated white along the veins.

Snowberry (*Chiogenes hispidula*)
Creeping, with leaves about ⅓ inch long, white flowers in the spring, followed by white berries.

Trailing Arbutus (*Epigaea repens*)
Creeping, leaves to 3 inches long. Prized for its extremely fragrant pink and white flowers very early in the spring. A Japanese species, *E. asiatica*, is similar but with more oblong leaves.

Galax (*Galax aphylla*)

Stiff, shining, heart-shaped leaves, as much as 5 inches across, turning beautiful bronze in autumn. Small white flowers in spring.

Japanese Holly (*Ilex crenata*) See page 206.

Three varieties of Japanese holly can be used in rock-gardens. *Ilex crenata helleri* is suitable for large gardens. It has tiny dull green leaves and grows in a spreading compact mound. The variety *convexa* has larger, glossier leaves, is less compact in growth and gets to be a large plant unless clipped, while *globosa* grows in a very compact ball.

Pale Laurel, Bog Kalmia (*Kalmia polifolia*)

Two varieties of this relative of the well known mountain laurel are good rock garden plants. *Kalmia polifolia nana* is a dwarf horticultural form which grows to about 18 inches. The flowers are rose-purple. *K. polifolia microphylla* has leaves only about ¾ inch long and grows to only 8 inches in height.

Honeysuckle (*Lonicera*)

Lonicera pileata is a very hardy evergreen honeysuckle which will sprawl over the rocks. It has shiny leaves and whitish fragrant flowers. Of more delicate texture is *L. nitida,* a small upright shrub with small, shiny, bronze leaves. It is not quite so hardy as the other.

Alpine-azalea (*Loiseleuria procumbens*)

This northern plant makes mats 6 to 8 inches high of leaves mostly less than ¼ inch long and has very small white or rose flowers.

Partridgeberry (*Mitchella repens*)

Creeping, with leaves to ¾ inch long, dark green and shiny, often with white veins. The small white flowers are twinned, and are followed by bright red, long-lasting berries.

Rhododendron

R. carolinianum, most suitable for the large rock garden, reaches 6 feet, with leaves to 3 inches long, pale rose-purple to white flowers.

R. chryseum grows to 2½ feet. The leaves are only about ½ inch long, the flowers are yellow.

R. fastigiatum reaches up to 3 feet, has lilac-rose flowers.

R. ferrugineum also grows to about 3 feet. The pink flowers are produced in late summer.

R. impeditum has short branches and reaches only about 20 inches in height. The leaves are less than ½ inch long, the flowers purple-blue.

R. racemosum, one of the most attractive of this group, grows to about 6 feet. It has pink, bell-shaped flowers.

R. russatum reaches about 3 feet in height. It has flat clusters of flowers of deep purple-blue color, with white throats.

Oconee Bells (*Shortia galacifolia*)

Bronzy, rounded leaves up to 3 inches in diameter grow up to 8 inches above a creeping rootstalk. White flowers in spring.

Reeves Skimmia (*Skimmia reevesiana*)

Hardy along the coast as far north as New York City, this 2-foot shrub has white flowers and dull red fruit.

Germander (*Teucrium chamaedrys*)

Germander grows to about 1 foot in height, has ¾-inch, toothed leaves. The red-purple or rose flowers are borne in loose spikes. Good for borders or low hedges.

Flournoy

Trimmed and untrimmed boxwood as used in colonial garden at Gunston Hall in Virginia.

ON GROWING BOXWOOD

What to do and what not to do . . .

A. G. Smith, Jr.

MOST boxwood troubles are man made, usually the result of too much or of misdirected care. Among some people the poor boxwood seldom has an opportunity to develop naturally. They call in many "experts" who give conflicting opinions; then to be on the safe side all the recommendations are tried.

In due time the box begins to look sick. The treatments are repeated and new ones are tried. The full-time gardeners feel the responsibility and experiment some on their own. After a few years of this it is impossible for anyone to say what caused the trouble. Maybe the plants just die of the jitters.

In regions where the winters are not too severe, boxwood is not a delicate plant; its requirements are few and if these are satisfied it thrives with little care. For example, for more than 35 years I have watched a boxwood of an intermediate dwarf type in the nearby town of Cambria. Its base is on top of maple roots and the boxwood is against the tree trunk. It has passed through many bad seasons but always seems to look about the same. No one has ever watered,

McFarland
Korean boxwood (*Buxus microphylla koreana*).

fed, sprayed, or pruned it as far as can be determined. For years it has stood in a narrow strip between the sidewalk and the curb. It has a western exposure and is 2,200 feet above sea level.

Planting

The best season for transplanting boxwoods is early spring but if care is used they may be moved at any time of the year. The kind of soil in which they are planted is not of great importance, so long as it is in good mechanical condition and is well drained. Boxwood does demand good drainage; the plants often die in soils that become water-logged after rains or applications of the hose. Also, in low or poorly drained places the bark of the plant may split and loosen around the trunk after sudden freezing.

In good soil the hole for the plant can be about 2 feet wider than the root ball. The plant should be set only to the same depth as it was before transplanting, or even a little less deep. Placing peat, compost, manure, etc. in the hole under the plant is not recommended. This practice is apt to cause settling of the plant later, and this, like deep planting, leads to trouble. Boxwood is a shallow-rooted plant, like many other broad-leaved evergreens, and its roots smother if buried too deeply in the soil.

After planting, apply a *level* mulch of peat, sawdust, peanut hulls, or any similar material, but not more than 1 inch deep. It must not be heaped up in a cone about the base of the plant. Established plants need not be mulched; too heavy mulching will cause smothering of the roots.

Keeping Roots Covered

While boxwood roots must not be buried deeply in the soil, neither must they be exposed. Because they are so near the surface, a certain amount of care must be taken to see that the soil is not washed away or otherwise removed. Boxwoods standing under the eaves of churches or other buildings where the run-off from the roof washes soil away are often thus injured. Sometimes in such situations, or near downspouts, water also stands long enough to drown the plants. In the sandy soils of eastern Virginia, old boxwood plants have been found to be damaged by chickens making dusting holes under them, exposing and breaking the roots. Such damage to the roots may go on for years without any change in the appearance of the plant, then, all at once, entire branches may develop an off-color or die following a sudden, severe change in the weather.

Location, Spacing, Winter Protection

Boxwood is not fussy about exposure; it will grow in partial shade or in full sun. In winter, however, full morning sun may cause damage by rapid thawing of the foliage. Snow-fence or lath covers may help to protect plants from this sunburn. Plastic sprays are used by some nurserymen. I have not had experience with them. (See page 266.)

The distance between plants being set out for hedges or borders varies with the final height and width desired. For a very low edging, 10 inches is enough; for a tall hedge, 2 to 5 feet.

Pruning

Boxwood must be pruned to keep it at the desired size and to promote good growth. It can be done at any time, but is best just before new growth starts in the spring. Remove enough weak, crowded branches and twigs from the upper half of the plant to admit light and air to the inner branches. If necessary, larger branches may be shortened. Box should not be clipped as privet and some other plants are. Proper thinning every year will develop a strong, stocky growth; clipping alone will weaken the plant.

Fertilizing

Boxwood need not be fertilized every year; exactly how often will vary with soil and growing conditions. If the appearance of the plant suggests that fertilizer is needed, a little chicken manure and a light application of bone meal or superphosphate may be scattered around the plants in early spring. Do not cultivate close to the plants; this damages the shallow roots.

Pests

Boxwood leaf miner is the most serious insect pest. It can be controlled by spraying all leaf surfaces just before the flies emerge with 1 ounce of 50 per cent DDT wettable powder in 3 gallons of water, repeating in 6 to 8 days. Malathion also may be used (see PLANTS & GARDENS, Spring 1955, page 17) and may be better than DDT because its use is not followed by the increase in red spider mite infestation that often follows DDT. Mites can be controlled by syringing the boxwood with water under pressure a few times in spring and summer. This washing of the foliage inside and out will be most effective if done about sunset so the foliage may stay wet overnight.

Shelter shades boxwood from winter sun and protects against breakage by ice and snow.

Roche

During recent dry, hot seasons many boxwood plants have been injured by oil sprays. I no longer recommend their use.

Nematodes of several species are found in the soil around boxwood in many sections of Virginia. Where the boxwood is given a fair chance, the nematodes do not do any harm. However, after the boxwood has been cultivated, sprayed, mulched, etc. and these treatments have been followed by a cycle of bad weather, the nematodes are blamed for everything that follows.

One group of dwarf and tree boxwood plants at West Point, Virginia, lost most of their leaves. A local professional worker sent specimens away for examination. The diagnosis was that the plants had been damaged by the banana nematode. When I visited the home later, I learned that the owners had applied a heavy dusting of wettable sulfur which had been sold to them as the proper material for boxwood. About 20 plants on their place which did not get the sulfur remained in good condition. I have seen them twice since the incident occurred. The nematodes are no doubt there too.

A few of the large dwarf box at Stratford, birthplace of General Robert E. Lee, in Westmoreland County east of Fredericksburg, have lost much foliage and some branches during recent bad seasons. All the trouble has been charged to nematodes.

In this case I know the history of the plants because I have examined them from time to time since the gardens were restored. A gardener who was employed there saw to it that no weeds or wiregrass (Bermuda) were allowed to grow near these plants. So he dug deeply enough and often enough to keep the root area perfectly clean. The pity was that he kept the area as free of boxwood roots as he did of wiregrass. I examined these plants a few days after the nematode specialists were there. No roots were left in the upper 4 to 5 inches, and the soil was soft and loose.

Just across a low brick wall there were 10 or more old dwarf plants which had been put there for future use. The area had been mowed and there was no sign of cultivation. These plants were in excellent condition with very firm growth and perfect color. Their roots were matted with those of Bermuda grass.

One dwarf boxwood about 20 inches high was shipped to me from Gastonia, North Carolina, after much correspondence about a local diagnosis of nematode injury. This plant, like others in this group, had received "a scoop of stable manure each fall and a pound of complete fertilizer each spring." Two small branches, one on each side, were green close to the ground. The remainder of the plant was brown and dead. The roots were clean, but shriveled. I cut out all the dead branches and set what was left in my garden. After four pretty bad seasons, it is now a nice, compact plant exactly 20 inches high and 19 inches wide. Since it was planted with the original North Carolina soil, I presume the nematodes are still with it.

Natural Variation and Propagation

The varieties of *Buxus sempervirens* in Virginia are too numerous to be listed by name. From 1,000 seedlings it would not be difficult to name 100 distinct varieties. If examined closely, all would be different.

The variations might include: rate and habit of growth; resistance to cold, heat and drought; arrangement of leaves; form, color and size of leaves; color of new stems; density of plant, etc. Thus, if a superior type of plant is to be obtained, of known growth performance, it must come from a parent plant by vegetative propagation. Indeed, rooting of boxwood cuttings is very simple, and is the commonest means of propagation. Try cuttings in late summer for rooting out-of-doors in sand. Protect from direct sun and wind and keep moist. Cuttings of dwarf box should be about 6 inches long, of tree box, about 10 to 12 inches.

HOLLIES FOR EASTERN GARDENS

How to grow, how to use . . .

Robert B. Clark

IN THE border plantings of gardens and along property lines an occasional well-placed accent is often needed. By their foliage, evergreens easily provide this feature in winter. In summer the mass, shape, or foliage texture are the traits that make a plant outstanding. Glossy leaves, too, help give distinctiveness to a wall of foliage. Hollies are suitable subjects when a compact-growing variety is chosen.

Broad-leaved evergreens are usually shade-tolerant plants since they retain their leaves throughout the year. This latter feature permits them to begin growth earlier and to continue growing longer than trees green only in summer. Of course, if the canopy admits too little light during the summer months, any undergrowth will be spindly. Welcome as they may be, shady spots are difficult to manage. The establishment of a holly might improve the situation. Beware of root competition and above all do not expect quick results.

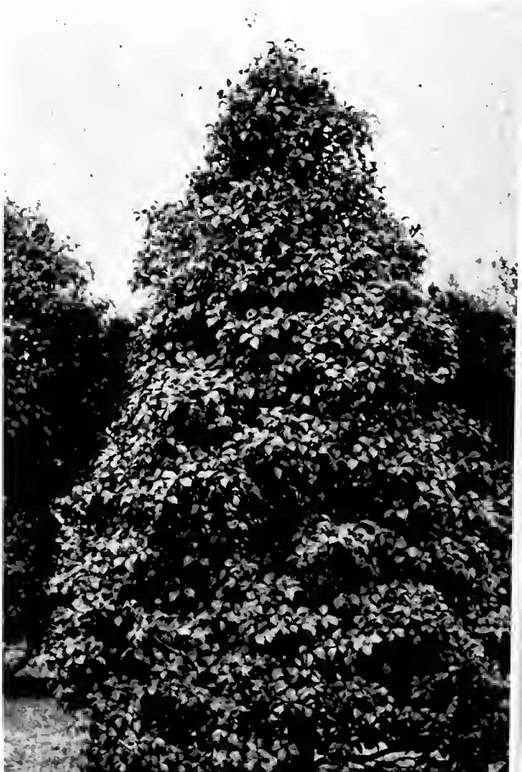
At least two dozen species of evergreen hollies are adapted to gardens of the eastern seaboard. Some of these are successfully grown beyond the mid-Atlantic states. Eight species are native to the southeastern states, two extend north to Cape Cod, Massachusetts. The inkberry (*Ilex glabra*) is even found in parts of Nova Scotia.

RED VELVET, a variety of American holly with natural conical growth, in orchard of New Jersey Silica Sand Company, in Millville, New Jersey.

American Holly

The familiar American holly (*Ilex opaca*) is suitable for a living Christmas tree. Century-old trees attain heights of 50 feet or more, but people have not been planting holly for very long, hence cultivated plants taller than 25 feet are seldom seen. Pruning during the holiday season will furnish sprays of red-berried foliage for home decoration. Cut branches up to 18 inches in length from the same section every third year. This is an approved method of pruning hollies for compactness.

Author photo



Male flowers of holly are borne in clusters and produce pollen, but no berries.

Roche photos

Female flowers of holly produce berries if pollinated. Male and female flowers are borne on separate trees; to insure pollination (chiefly by bees) at least one tree in every planting should be male.

Where to plant the specimen holly is frequently a problem. It is best grown as a free-standing tree at the edge of an open lawn—many gardeners will want it in full view of the living-room window. Lower branches, if so inclined, should be allowed to reach the ground. Suggested species and varieties are listed on page 242.

Foundation Plantings

The foundation planting is a good place for shrubby types. One should first regard the dimensions of the house, then visualize the ideal mass appearance that the plant is capable of attaining. After these points are observed one may select the holly type. The dwarfer forms of the Japanese holly (*Ilex crenata*), the compact Chinese holly (*I. cornuta pendula*), the American *I. glabra,* called inkberry in the North, gallberry in the South, and *I. opaca* SPREADING (MARYLAND DWARF) are useful.

Hollies for Hedges

Several hollies lend themselves to hedge purposes. Uniformity of stock is the primary requirement. All plants ought to be of the same variety as well as size. The desired ultimate dimensions of the hedge determines planting distance, the taller the hedge the greater the spacing between plants. Well grown American hollies 2½ to 3 feet tall may be spaced up to 3 feet between trunks for an eventual 4- to 5-foot hedge. A screen planting, which is essentially a hedge that receives less frequent trimming, may be spaced much farther apart, assuming that 5- to 6-foot plants are used. If two large-sized trees are intended to screen a view, the distance may be as much as 20 feet between trunks.

How to Plant

Planting operations are simple provided young nursery-grown plants are used. When larger trees are involved, special equipment and often a good deal of skill are required. The site should be well drained, and the soil well aerated. Hollies will survive in heavy soils, but rarely under such conditions do they grow well. Lighten heavy soils by mixing in liberal amounts of sharp sand and peat or well-decayed leaf mold. (See PLANTS & GARDENS, Spring 1956, page 48.) Many species grow naturally in pure sand, but water is close by and air is either in the water or in the soil.

Transplanting is best done in spring before growth has started. The soil should be friable, easily worked, and not wet. The hole should be adequate in diameter to allow space for maneuvering, its depth should be equal to the height of the ball. As with all evergreens the plant should be balled and burlapped. A liberal amount

of leafmold or humus is incorporated with the backfill. This is frequently compacted by stomping heavily with the heel to exclude air pockets. A low dike of soil to collect surface water is left to encircle the newly planted holly. Fill this shallow basin with water to overflowing and allow it to settle. A single watering should be sufficient for several days. Restrain the urge to water, but watch the condition of the soil by scraping the surface. If the freshly exposed soil is darker, moisture is adequate. Wilting is another test for water need, but the careful gardener never permits this stage to arrive. He may, however, bring it about by excessive watering—too much water in the soil can drown the plant, causing the leaves to droop.

No mention has been made of fertilizer, since too much in dry weather often leads to foliage burning. A year or two after transplanting a holly tree a handful of complete fertilizer can reasonably be applied in the spring. Spread the fertilizer in a ring around the plant and work into the soil. This is particularly desirable if the tree makes short, slender new growth, bearing pale green foliage. Such growth is often a sign of insufficient nutrients in the soil, indicating a need for fertilizer. On the other hand, spectacular growth of shoots, especially late in the season, is a sign of too much nitrogen. These overdeveloped shoots are unsightly, and because they are soft and succulent are subject to winterkilling. The best rule is to be patient and go slow with the fertilizers.

Hollies, like many other broad-leaved evergreens, are shallow-rooted. Mulching prevents roots from drying out or freezing. Do not cultivate deeply around holly trees as this will destroy many of the surface feeding roots.

Freshly dug hollies have been largely deprived of their small feeder roots. It is important in transplanting to restore the balance between roots and shoots. This can be done by pruning—simply cut off the tips of many of the branches. This also affords an opportunity to shape the plant into desirable form. Certainly pruning at this stage is often the difference between success and failure in transplanting.

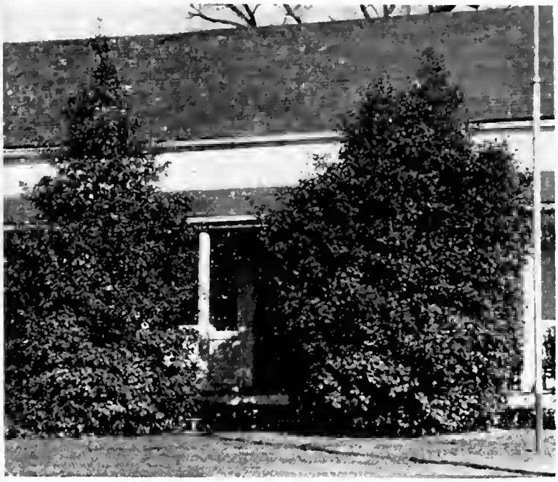
Pests

The most troublesome pest of American and English hollies is leaf miner (see PLANTS & GARDENS, Spring, 1955, page 17). This insect deposits its eggs just beneath the upper surface of the leaf. As the larvae develop they move about forming circuitous channels which mar the beauty of the leaf. Control is effected by an application of DDT (3 tablespoonfuls of 25 per cent emulsion in 2½ gallons of water) at the time of emergence of the adult flies. This usually happens as the old leaves are shedding (during May in New Jersey). One application is sufficient when effectively timed.

Red mites which appear on the lower surface of convex-leaved Japanese holly produce a dull grayish appearance of the upper leaf surface (see PLANTS & GARDENS, Spring 1955, page 21). These are controlled at 10-day intervals throughout the hot summer days by using the deadly parathion spray or a sulphur dust.

Hollies come in two sexes. It is advisable to grow both sexes of the same species in order to insure adequate pollination for a berry crop. Honey bees are the pollinating agents, therefore favorable weather during the blooming season is important. The proportion and distance between male and berry-producing plants is not known for certain. One male among 25 trees would seem adequate. If only two plants are involved they ought to be within ½ mile of each other if a satisfactory crop of berries is to be had. Bringing the plants closer will undoubtedly result in increased yield. If provided a bouquet of male flowers when in bloom, the bees will transfer pollen to the flowers on female trees and thus insure berries in the autumn.

From the extensive list of available hollies, I favor the ones indicated on pages 242 and 243 which have been growing in the Rutgers University Arboretum for the past ten years. These are listed according to suggested uses.



Roche
Different varieties of American holly (*Ilex opaca*) vary in growth habit.

University of Washington Arboretu
Among the smooth-leaved hollies is *Ilex integra.*

SELECTED LIST OF HOLLIES FOR CERTAIN USES OR HAVING SPECIAL CHARACTERS

For specimen plant	English holly (*Ilex aquifolium*)—many varieties, Chines holly (*I. cornuta*), American holly (*I. opaca*) varieti DAVID (male), FARAGE, HALCYON, JUDGE BROWN, MIS HELEN, RED VELVET, BOYCE THOMPSON #3
For hedge	English holly, Chinese holly, Japanese holly (*I. crenata*)- many varieties, inkberry (*I. glabra*), Perny holly (*I. pernyi*), American holly varieties CLARK, DAVID, HEDGEHOLI
Spreading habit	Chinese holly varieties *pendula* and *rotunda,* Japanese hol varieties *convexa, helleri, mariesi, stokesi,* GREEN CUSHIO GREEN ISLAND, American holly variety SPREADING (MAR LAND DWARF)
Dwarf habit	Japanese holly varieties *helleri, mariesi, stokesi,* GREE CUSHION, GREEN ISLAND
Dense foliage	English holly—many varieties, Chinese holly variety *pendula,* Japanese holly—many varieties, American holly varieties ARGENTINE, BROWN #9 (male), CLARK, CUMBERLAN, DAVID (male), EAST PALATKA, FARAGE, RED VELVET, S. MARY
Male flowers	All species, American holly varieties DAVID, BROWN #9

University of Washington Arboretum

One of the largest-leaved hollies, *Ilex latifolia.*

Roche

Ilex crenata var. HELLERI is both low growing and slow growing, so makes a desirable dwarf shrub for special plantings.

Dark green foliage	English holly variety WILSON, Japanese holly—many varieties, *Ilex integra,* American holly variety FARAGE
Glossy foliage	English holly variety JAMES G. ESSON, Japanese holly variety *convexa,* American holly varieties BROWN #9, CUMBERLAND, EAST PALATKA, OLD HEAVY BERRY
Small leaf	Japanese holly—many varieties, inkberry, myrtle dahoon (*I. cassine myrtifolia*), Perny holly, yaupon (*I. vomitoria*), Yunnan holly (*I. yunnanensis*), American holly varieties DAVID, HEDGEHOLLY, ST. MARY
Large leaf	English holly variety *heterophylla,* lusterleaf holly (*I. latifolia*), *Ilex rotunda,* American holly variety OLD HEAVY BERRY
Crinkled leaf	English holly—some varieties, American holly varieties DAVID, HEDGEHOLLY, PERRINE, ST. MARY
Smooth (spineless) leaf	English holly—some varieties, hummock holly (*I. cumulicola*), Perny holly, American holly variety EMILY
Clustered berries	English holly, dahoon, Chinese holly, inkberry, *Ilex rotunda,* yaupon, American holly varieties MANIG, MISS HELEN, PERRINE
Yellow berries	American holly variety *xanthocarpa* BOYCE THOMPSON

ENGLISH HOLLY

How to grow this choice broad-leaved evergreen—told by one who does it

Kathleen K. Meserve

ENGLISH holly (*Ilex aquifolium*) has featured in the religious rites and superstitions of various sections throughout Europe since the time of Zoroaster; today it ranks as an outstanding ornamental. In the United States, English holly found a moderate climate to its liking in the Pacific Northwest. Indeed, so suitable to its growth is this area that the holly has seeded itself and become naturalized. The same is not true of the eastern part of the country. The extreme summer heat in the southern states and the severe winter cold in the north, limits the areas in which English holly can be grown.

In well protected locations, English holly can be found as far south as the coastal sections of Georgia and as fa north as Cape Cod, Massachusetts. seems to do best along the coast of Vi ginia, Maryland, Delaware, New Jerse and Long Island, and in the Paci Northwest. On Long Island, however, is interesting to note that we have n found an English holly which antedat 1903.

Hardiness

The rather limited range of Engli holly in the eastern United States h given rise to the idea that it is not hard This notion may be false and is probab based on the performance of a few ten strains of English holly. Evidence is b ing gathered which indicates that t

Partially sheared hedge of English holly (*Ilex aquifolium*) is attractive and makes f midable barrier along sidewalk.

McFarl

English holly variety WILSON is considered fine for foliage luster and growth habit.

Roche photos

Burford's Chinese holly (*Ilex cornuta burfordi*) has a sheen comparable to that of English holly and tolerates greater extremes of winter and summer temperatures.

English holly has a far wider range of hardiness than has been heretofore suspected in this country. Through breeding and selection from seedlings of hardy stock, hardier hollies can be developed, as evidenced by established English hollies growing in such severe climates as those at Buffalo and Syracuse in New York, at Lenox, Massachusetts, and in the Adirondack Mountains. Further encouraging evidence of hardiness is found in the holly imported from the mountains above the town of Sarajevo, Yugoslavia, to the Missouri Botanical Garden, where it has been growing more successfully than many varieties of the supposedly more hardy American holly (*I. opaca*).

In our experience of growing several thousand English holly seedlings, we have found great differences in hardiness between seedlings from different trees. We have also found that hollies selected in the more moderate climate of the West Coast do not always adjust to our climate as well as some of the varieties growing in the East. Of particular interest is a group of holly seedlings grown from an English hybrid which was on the Eldridge Estate in Great Neck, Long Island. The original Eldridge tree has been propagated and distributed under the erroneous name of *Altaclarensis*. Among the many seedlings from that tree, which have been distributed among institutions, nurseries, and private gardens, there are several well worth mentioning for both their hardiness and beauty. One, in particular, has attracted attention and has been selected and named JAMES G. ESSON (in spite of the fact that it is female). This is only one example of a strain of holly that may extend the area in which the species can be grown.

Where low winter temperatures are the limiting factor, more resistant strains may yet be found among the English hollies, and especially among hybrids between English holly and a closely related species from the Canary Islands. For areas where summer heat is great, English holly may also offer selections more resistant to burning than any we now know; but a more likely answer to the holly question for such climates at present seems to be Chinese holly (*I. cornuta*). This species, native to China, is beautiful and variable, and as yet but little explored. To date we know that it will stand summers where the temperatures rise to 109° to 118° F.

Experimenting with Holly

Advancing the holly frontier lies largely in the hands of the home gardener who is willing to do a little experimenting.

University of Washington Arboretum

There are more than 50 varieties of English holly that are distinctly different from one another. Left to right the varieties are: *myrtifolia*, *ferox variegata*, and *recurva*.

One experience means nothing; many experiences tell a story. However the gardener may approach this experiment, whether by growing a few holly varieties, or growing seed obtained from particularly cold or hot sections of the world, or by crossing one species with another, his efforts will contribute to the little knowledge which we have. Even failures may help—sometimes they are forgotten but they can be as important to the whole story as the successes. Only in this way will more useful, more beautiful, and hardier hollies be found to enrich our winter gardens in temperate or cold climates.

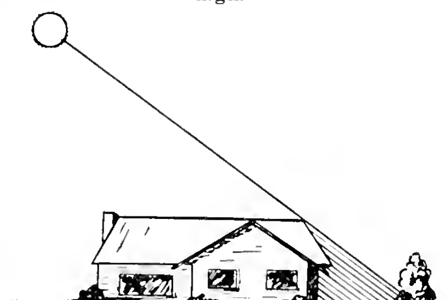
In order to go ahead with experiments, the gardener must learn what he can about holly. Perhaps some of our experiences will be helpful to others.

Our "laboratory" has been our plantings of thousands of English hollies. We have planted blocks of seedlings in different exposures, we have planted the same variety in different exposures, and we have studied them through all the seasons. There are so many characteristics to consider and there is so much variation between individual plants, it would be difficult for the human mind to catalogue them all. We have found, however, certain basic facts about its culture here on the North Shore of Long Island which we believe may be useful elsewhere.

When to Plant

Spring is the ideal planting time for English holly. Although the recent winters have been mild, there is always the possibility that the next one will be a good old-fashioned "freezer." In that case, the holly with its roots below the frost level is the holly which will come through best.

Properly placed holly tree on north side of house gets sunlight in summer when sun is high.



Tree is protected from low winter sun by shadow of house.

Transplanting holly should be done as early as possible in the spring and not later than the first of May. If the transplanting is done early, the holly tree will then grow its new roots in its new location. These roots will be needed through the drought and hot summer to follow.

Potted hollies or those which have been grown in the house after the Christmas season are best put outside after the danger of late frost is over but before the weather becomes too hot. Any soft, new growth should have a slight protection from the sun for about a week or until it hardens.

Where to Plant

In choosing a location, consider your holly. A hardy variety can be put in full sun and wind. All hollies, however, will remain more handsome if the foliage is protected from the winter sun and given full summer sun. This can be done by properly placing the plants on the north side of tall evergreens or buildings. If the distance from the shelter is just right, the plants will receive sun in the summer, when the sun is high and shadows are short, but will be in the shade in winter when the sun is low (see diagram). Air circulation is important. A location on the lawn is better than one against the house. We have found that winter sun reflected from a white house back on the holly can be most damaging, particularly if the holly is sheltered from the wind. Protecting a holly by cover such as burlap in the winter is not desirable. A variety or species which must be covered during the months when it is at its prime and its beauty most wanted should not be grown.

High shade or sun filtered through deciduous trees is often recommended. We do not agree. Any shade during the summer limits the potential strength of the holly. Any sun during the winter and particularly during late February and March is a hardship. Under deciduous trees the holly gets shade in summer, sun in winter, just the reverse of what can be called protection.

When planting, we recommend pouring very wet peatmoss in the bottom of the hole and setting the holly on top. Roots will rapidly grow down through this and the tree can better resist the heat of the summer and cold of the winter to come.

Sandy soil is ideal. Where soil is heavy, plant on a slope but never where puddles form after a rain.

Watering

A newly planted holly may need watering during the first two or three summers but do not encourage late growth by watering after the first of September. By Thanksgiving, however, if the ground is dry, a good watering is in order—this late in the season, new growth will not start.

Fertilizing

Feed holly after winter sets in. We prefer December or January and use a slow, organic fertilizer. The colder the climate, i.e., the shorter the summer, the less fertilizer. Late spring or summer feeding, like late watering, encourages growth late into the fall, and the tender new branches are often winter-killed. Slight winter-burning which is liable to occur on small plants is not serious, but if the winter killed shoots are numerous, the above-ground parts of the plant will be small in relation to its roots. Once this condition starts, winter-killing will tend to increase each year. Should this situation arise, we recommend transplanting the holly or giving it a good root-pruning in the spring.

Remember this same balance when pruning a small plant, and trim it but lightly, and in the spring. As it grows, however, more can be cut each year until finally you can deck your halls with boughs from your own holly tree at Christmas time. Remember, English holly, like American, has both male and female trees. It is necessary to have both if berries are expected.

HYBRID RHODODENDRONS FOR THE PACIFIC NORTHWEST

. . . and similar climates elsewhere

J. Harold Clarke

Rhododendrons are standard plant material for gardens in the Northwest. The number of named varieties commonly available in the trade exceeds one hundred, with two or three times that many appearing in collectors' gardens. In addition, more than a hundred species of rhododendrons are being grown by fanciers in the Northwest.

Usually the gardener starts with one or two of the more common, standard named varieties, goes on to less common varities, then, if he becomes really interested in this group of plants, to the dwarfs, and finally to the species. It might be expected that one would go from the common wild types (species) to the more highly refined and selected horticultural varieties. Actually, the horticultural varieties have been available in this country a longer time than many of the species which have been brought in from Asia only within the last few years. Since the species are preferred mostly by the more avid rhododendron growers, this discussion will be limited to the cultivated horticultural varieties.

My remarks apply particularly to that part of the Pacific Northwest from the Canadian border south to the California border and west of the Cascades. Of course, rhododendrons are grown north and south of these limits, but in general the western portion of Oregon and Washington does constitute a rather unique plant growing region. This area is quite variable as to topography and climate and, of course, there are many local areas where the soil is too rocky, or the elevation too high, or the slope too steep, or the drainage too poor for optimum rhododendron growth.

University of Washington Arboretum

Hybrid rhododendron AZOR has soft salmon pink blossoms produced in abundance

A Favorable Climate

The climate is generally mild, temperatures usually going not much below 10° F. Rainfall is heavy during the winter. Summer temperatures near the coast are usually in the sixties or low seventies, while inland they are reasonably high although not very often above 90° F. Summer rainfall throughout the entire area is rather low and irrigation is necessary or desirable.

Suggestions as to varieties will be based chiefly on the landscape uses to which the plants may be put. Rhododendron flowers will usually be in good condition for 2 or 3 weeks on any one variety and the blooming season may extend from early February to the first of July if one has a fairly large collection. Furthermore, the foliage of many rhododendrons is very satisfactory in landscaping. It is evergreen (in the varieties discussed here) and offers a range in size, color, texture, and seasonal coloration.

For descriptions of varieties readers are referred to the recent publication, RHODODENDRONS 1956, published by the American Rhododendron Society, where about 250 varieties are described and given ratings as to general garden quality and hardiness.

Varieties Grouped As To Size

In grouping rhododendrons let us first consider the tall ones which might be used as specimen plants, growing by themselves, uncrowded so they may develop flowering branches from the ground to the top and produce symmetrical shrubs as wide as they are high, or perhaps wider. Varieties which may be leggy, but which have beautiful flowers and perhaps attractive growth in the top, may be used as background material for lower-growing rhododendrons, or other shrubs.

Lists such as this reflect personal taste and experience. The following varieties, which I would like to suggest in the tall group, might be expected to reach a height of 7 or 8 feet in ten years.

A. BEDFORD—lavender, dark eye
BEAUTY OF LITTLEWORTH—white
FAGGETER'S FAVORITE—silvery pink
LADY CHAMBERLAIN (for background planting primarily)—shades of orange to pink
LADY ROSEBERY—rosy pink
LODERI (various forms—the two finding most favor in the Northwest are probably KING GEORGE, pale pink, and VENUS.)
MRS. LINDSAY SMITH—white

There are many rhododendrons of medium size, reaching a height of 5 or 6 feet in ten years, which would be used a little differently than the tall varieties. They could be used in the shrub border, neither too far to the back nor too close to the front, or in base plantings if it is realized that they may reach a height of 10 or 12 feet in the course of twenty years. The following varieties are suggested in this group:

ANNIE E. ENDTZ—light pink
ANTOON VAN WELIE—carmine pink
BETTY WORMALD—pale pink center, pale purple blotch
CARITA—primrose
CORNISH CROSS—rose pink
COUNTESS OF DERBY—rose pink
CYNTHIA—rosy crimson
DAME NELLIE MELBA—pink
DAVID—blood-red
DIANE—primrose
DOCTOR STOCKER—ivory white
GRENADIER—deep blood-red
JAN DEKENS—pink, fringed
LODER'S WHITE—pale mauve edge fading to white
MARINUS KOSTER—pink, brown spots
MOTHER OF PEARL—blush, turning snow-white
MRS. E. C. STERLING—blush pink
MRS. G. W. LEAK—pink with brown-purple blotch
PILGRIM—soft pink
PINK PEARL—rose pink, fading to blush
SNOW QUEEN—pure white
JEAN MARIE DE MONTAGU—scarlet

In this general size class there are also several hybrids of the species *R. griersonianum*, which are brilliant in flower color, perhaps a little more tender to cold and possibly less attractive in foliage. In this group I would suggest

Roche

Hybrid rhododendron BLUE PETER.

AZOR—soft salmon
F. C. PUDDLE—orange red
FUSILIER—scarlet
SARITA LODER—pale salmon pink
SUNRISE—carmine lilac
TALLY-HO—bright scarlet

Then there are other rhododendrons which will reach 3 or 4 feet in a ten-year period. We do not call them dwarfs, although they are low growing and especially useful in the border:

BLUE PETER—pale lavender-blue, deep blotch
BOW BELLS—pink
BRITANNIA—bright crimson red
CORONA—coral pink
LADY CLEMENTINE MITFORD—peach pink, deeper margin
MARS—deep true red
MAY DAY—scarlet
MRS. FURNIVAL—light pink, sienna blotch
MRS. MARY ASHLEY—salmon pink, shaded cream
MRS. P. D. WILLIAMS—ivory white, brown spot
NAOMI (there are several clones in this group)—shades of pink suffused with green and lilac
PURPLE SPLENDOUR—deep purple, black spot
RADIUM—red
UNIQUE—flesh, changing to buff
VULCAN—brick-red

Among the dwarfs, which would reach 3 feet or less in ten years, there is a great deal of variation as to season, foliage, and type of growth as well as flowers. Some of these varieties will eventually go considerably above 3 feet and others will never reach that height. Suggested in this group are:

AUGFAST—blue
BLUE DIAMOND—blue
BLUE TIT—blue
BRIC-A-BRAC—white
CILPINENSE—pinkish white
CONEMAUGH—rose
ELIZABETH—light blood red
HUMMINGBIRD—pink, shaded vermillion
MOONSTONE—cream, edged pink
NEREID—orange pink
PRAECOX—rosy lilac
RACIL—shell pink
SAPPHIRE—blue
TEMPLE BELLE—pale rose

Plants May Be Moved

The selecting of a small group of rhododendrons from the above lists for use in a particular garden will involve a good deal of study if one is new in this field. These plants will live a long time and give a great deal of pleasure if properly cared for, and if they are properly selected and located in the beginning. Rhododendrons have a very fibrous root system and lend themselves quite readily to being moved with a ball of soil. Many fanciers set their plants rather close together with the idea that they can spread them out later or move them to some other location. Actually, rhododendrons are often dug, balled and burlaped, taken to flower shows, and then planted back in the garden with very little ill effect on the plants. This ease

of transplanting permits a great deal of flexibility in the use of these plants in the landscape plan.

Soil

In the Pacific Northwest it is probably safe to say that any reasonably good soil where a lawn and a garden can be grown will be satisfactory for rhododendrons. They require good drainage and a good supply of moisture during the summer. Mulch, such as sawdust, is very desirable as it permits planting on a soil that is well drained and perhaps otherwise would dry out too much during the summer. *Rhododendrons are very shallow rooted and any cultivation which involves stirring the soil an inch or more deep would cause damage to the roots.* Where a sawdust mulch is used, a portion of the root system will usually develop in the sawdust above the soil. Much has been written about the use of well rotted sawdust but personal experience indicates that fresh sawdust is quite satisfactory. The thing to remember is that, as decay organisms begin to break down the sawdust mulch, nitrogen will be deficient and the plants may become quite yellow. This can be offset by applying a nitrogen fertilizer, at least twice as much as would be used on the same soil for plants under ordinary cultivation. The plants are the indicators, and will tell whether they need nitrogen or not and whether you have satisfied their needs after you begin to supply an extra amount.

The general level of fertility to maintain, especially with respect to phosphorous, potassium, and other elements aside from nitrogen, will depend on the natural fertility of the soil. One should think not of a special rhododendron fertilizer program so much as a program for the particular soil in the garden. Rhododendrons do have one requirement which is different from many other plants: they prefer (and most require) an acid soil. However, most of the soils in the area discussed here are acid enough, especially in the regions where rainfall is high. In some of the marginal areas where the rainfall is relatively low there may be soils which are too alkaline for optimum growth. On such soils, it is usually satisfactory to use ammonium sulfate as a source of nitrogen as it will gradually cause the soil to become more acid. In very alkaline soils, of course, it may be necessary to use sulfur to acidify the soil. In such cases local advice from the county agent or other experienced people should be sought. Apparently, alkaline soils are unfavorable to certain plants partly because they prevent such plants from taking in sufficient iron, which is one of the minor elements essential to plant growth. There are now available certain forms of iron known as chelates, which will remain available to the plant even though the soil is alkaline. If in a rather alkaline soil rhododendrons are yellowish and do not respond to fairly heavy applications of nitrogen, try correcting this condition by the use of chelated iron.

University of Washington Arboretu

Hybrid rhododendron CYNTHIA.

Pests Affecting Rhododendrons

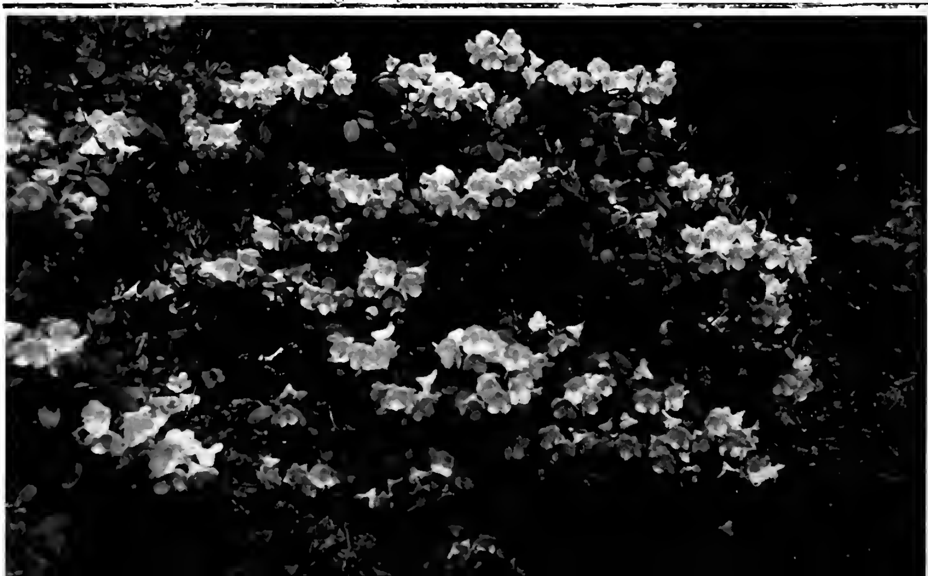
One of the most serious rhododendron pests in the Northwest is the strawberry weevil and two or three related weevils, which may girdle young plants or even older ones. Fortunately, these insects can be controlled by aldrin or chlordane. Some pests which are prevalent in the East and South, such as lace bug, are much less serious in the cooler regions of the Northwest. Slugs do occasionally cause damage, especially to younger plants, but metaldehyde baits or dusts are quite effective against them.

Because of the relatively high humidity in the Northwest, certain diseases such as the leaf spots and cane blights may be more frequently met with than in drier regions. In most cases, keeping the plants in a vigorous growing condition, plus some pruning out of diseased twigs or branches if they do appear, will be sufficient. Occasionally it may be desirable to spray with a weak bordeaux mixture or with one of the newer fungicides such as captan. Root rot diseases may occasionally cause trouble in poorly drained, heavy soils. Some varieties are more resistant than others but improving drainage, of course, is the primary factor in controlling this. Some of the new soil sterilants (see PLANTS & GARDENS, Spring 1956, page 51) might be considered under very special conditions. As a general rule, rhododendrons are no more likely to be bothered by insect and disease pests than are other shrubs and in many cases have proven remarkably resistant to injuries of this type.

Effect of the Freeze

After the disastrous freeze of mid-November 1955 it is difficult to discuss rhododendrons in the Northwest without bringing up the matter of injury during that period. It is the considered opinion of most rhododendron growers with whom I have talked that the experience of that freeze should not seriously affect the choice of varieties. It was the worst experience in some 40 years and many common trees which were considered completely hardy in this area were damaged or killed. It would seem reasonable not to avoid a variety which was injured at that time, when native trees, which have grown in the area from time immemorial, were also injured. It is true that certain varieties did come through with very little injury even under such unusual conditions. If one is planting rhododendrons where early fall and late spring frosts are very likely to be serious, then it would be desirable to select those varieties which have shown extreme resistance to such conditions.

Bell-shaped blossoms give hybrid rhododendron BOW BELLS its name.



University of Washington Arboretum

Naturalized planting of Dexter hybrid rhododendrons.

THE DEXTER RHODODENDRONS

Varieties not yet available, but an example of the hybridizing that should be carried on with many ornamentals

John C. Wister

WE OWE the beginning of the culture of hybrid rhododendrons in this country to two Boston amateur gardeners, H. H. Hunnewell and Edward S. Rand. On visits to England in the late 1850's and 1860's they happened to see the displays of Anthony Waterer's Knap Hill Nursery.

They imported plants which did so well in their gardens that, in 1876, Mr. Waterer ventured to send a great collection of some 1500 Catawbiense hybrids in fifty or more varieties to the Centennial Exposition in Philadelphia.

These plants with their many-colored flowers created a horticultural sensation. For the next quarter-century Mr. Waterer and other European growers found a lucrative market for their plants in the New England and Middle States. Here the foundation was laid for the present day rhododendron enthusiasm.

After the turn of the century, however, British breeders began to work with newer and less hardy species than those which had produced the so-called "Iron-Clad" Catawbiense hybrids. Most of those could not withstand the combination of too cold winters and too hot and dry summers which are characteristic of our East Coast. They did, however, flourish on our West Coast from San Francisco to Seattle and British Columbia. Their history, culminating in the organizing of the American Rhododendron Society and various regional or local societies, is well known.

Eastern gardeners long envied the West Coast growers who could enjoy these magnificent new flowers. Various Eastern breeders tried their hand at producing hybrids of similar beauty, yet adapted to eastern conditions.

Beginning of the Dexter Collection

One of these was the late Charles O. Dexter. In the early 1920's he retired from business and bought land at Sandwich on Cape Cod. Apparently, entirely by chance, he employed as the landscape architect for his new place Paul Frost, a life-long rhododendron enthusiast. Mr. Frost knew that Cape Cod conditions were ideal for rhododendrons and persuaded Mr. Dexter to buy out most of a great collection which John Farquhar, a

Boston seedsman, had imported before the days of the Plant Quarantine.

The flowers on these then little-known species and hybrids were so much finer than any previously seen in those parts that Mr. Dexter was fascinated. Mr. Frost quickly persuaded him to make crosses and raise seedlings, reporting this to Professor Sargent and E. H. Wilson at the Arnold Arboretum.

They at once began to help Mr. Dexter by supplying additional species and by arranging for shipments of pollen of rare species and hybrids from England. Here was an example of how the professional staff members of an Arboretum can lend such a hand to an amateur breeder that his work achieves importance.

This example will, I hope, be followed by other Arboretums, for I feel that by such actions they can do much more for the future of horticulture than they can by confining themselves entirely to their own special interests. Many amateurs have, without previous training, made noteworthy contributions to horticulture and most of them could obtain help from our horticultural institutions if they asked for it.

Mr. Dexter's work achieved definite and important results. From the strictly scientific point of view, however, it had its drawbacks. The exact status of some of the first plants he used for hybridizing is clouded with considerable doubt.

One of his best Farquhar plants, which he numbered #8, had come from Robert Veitch in Exeter, England, under the name of *R. fortunei*. While the Veitch nursery was careful, this plant differed enough from the typical species as to raise the possibility that it was really an accidental hybrid crossed by bees.

Mr. Dexter left no written records and apparently relied upon memory in writing on his labels the parentage of his hybrids. Some people state he became so forgetful that he placed the same code number on entirely different plants.

When the plants from his crosses began to bloom, the flowers were so unusual and so beautiful that they soon attracted many visitors. Although he was not anxious to part with plants, visitors so importuned him that he began to give away flats of seedlings and even to sell a few larger plants. In this way fifteen, twenty, or more great collections of these plants were started in other places.

Early Selection Neglected

In any plant hybridizing, in addition to a few really fine things which develop, there are great numbers of mediocre plants not worthy of further propagation. That was particularly true of the Dexter hybrids which were loosely called "Fortunei hybrids."

It is clear that there should have been most rigorous selection. If this had been done 99 out of every 100 seedlings would have been destroyed rather than distributed. There would have been better opportunity to concentrate the effort on the very best and to make selections which would by this time have been of great value.

As it was, Mr. Dexter went happily on with this work, growing some 10,000 seedlings a year over a period of nearly 20 years.

It was only after his death that rhododendron growers began to realize what a great contribution he had made. At that time a small group of men who were interested in rhododendrons got together and began to visit collections where the Dexter seedlings were grown. They found that most of the plants were not distinctive, but among them here and there were some gorgeous new hardy varieties of untold value to the New England climate. What their value will be on the West Coast, where they will have to compete with the finest British varieties, is not yet known.

Characteristics

Among the characteristics of these seedlings are rapid growth and the habit of flowering when extremely young. The flowers, which are large, bloom mostly before the Catawbiense hybrids, that is in the Philadelphia area in mid-May rather than late May or early June. The

lowers are often fragrant. Most are pale pink, but there are some lovely clear rose pinks without any tinge of purple or blue. There are also some very fine scarlets, some apricot yellows, and an occasional white. Further breeding may produce a still wider color range.

Among the men who became interested in these new plants, and who journeyed to visit sixteen different collections were Dr. Clement G. Bowers, Dr. Donald Wyman, Dr. Henry T. Skinner, Paul Vossberg, David Leach, Paul Bosley, and the writer. There were, of course, differences of opinion as to the value of particular plants, but there were also definite conclusions on which all agreed. In the gardens visited these plants were tagged and numbered.

Through the kindness of the owners of the various collections, cuttings were rooted and have now been distributed to a number of public collections for further testing. The first of these cuttings came to the Scott Foundation at Swarthmore, and later from there plants were distributed to the National Arboretum, to "Planting Fields" of the Long Island Agricultural and Technical Institute, to the Arnold Arboretum, and to some private growers. From these many varied seedlings now known by code numbers, it is hoped that final conclusions will be drawn when they bloom side by side in these places.

The best varieties can then be selected and named, and turned over to nurseries for mass production. In the meantime interested persons can visit the collections where these are being grown and see for themselves the progress that is being made and what the different varieties have to offer.

When the value of Mr. Dexter's work was first recognized, great difficulties were experienced in propagation of selected clones.

It was not until about five years ago that rhododendron propagation by cuttings became successful enough to make it worth while to take cuttings from small rare plants. Much of this work has now been simplified. It is well explained in the new book RHODODENDRONS which has just been published by the American Rhododendron Society. The chapter on propagation is by James S. Wells, and is, by far, the best exposition of the different methods of rhododendron propagation that has ever been brought together and published in one place. It is, of course, based on the investigations of many others and on the practices of many nurserymen. Persons who grow rhododendrons either for pleasure or commercially will benefit by reading the chapter.

Hardiness

The climatic limitations of these seedlings are not yet fully understood. They have been grown on Cape Cod since about 1924. The earlier ones withstood the severe winter of 1933, the coldest in the history of the weather bureau. Plants have been grown further north, but near the sea, in Ipswich and in Newburyport, and are said to have withstood many years when the temperature ranged from 10° to 20° below zero F. or even colder. They have been grown in Mentor, Ohio, where there are many cold winters. In one nursery there, they are grown entirely in the open, just like any other field crop, and have stood both sun and wind in winter. In most other places they have been given sheltered locations under trees or sheltered by a hillside.

Mr. Dexter's work is only the beginning of what should be done to bring greater variety into the hardiest strains of rhododendrons, and to make it possible to grow rhododendrons in areas where they were little known before. No one knows what the future may bring forth when enough plants are grown by interested amateurs and selected for different areas. In this every amateur, even with the smallest garden, can help. It is hoped that the American Association of Botanical Gardens and Arboretums can work with these amateurs and so guide them as to make possible production and distribution of many fine new plants in the future.

PROPAGATION OF BROAD-LEAVED EVERGREENS

A simplified method based on experiences at the Holden Arboretum and elsewhere

Lewis F. Lipp

PROPAGATION by cuttings of the broad-leaved evergreens, using a combination of hormone powder, peat, sand, and granular styrofoam (a foamed plastic) for the rooting medium, plus a polyethylene plastic tent for covering a flat or box, has now simplified the way of increasing many formerly hard-to-root evergreens.

Propagating Unit

To make the propagating unit, a greenhouse flat, preferably a deep one, is filled with a mixture of 70 per cent peat, 10 per cent sharp clean sand, and 20 per cent granular styrofoam. Cuttings, made and treated as directed below, are set in this and watered well. Next a wire frame is put over the flat to serve as a suppor[t] for the polyethylene film. Before put[t]ing on the film, a layer of damp cheese[-]cloth may be spread over the frame. Ove[r] this is placed a sheet of polyethylen[e] plastic large enough to tuck under th[e] sides, ends, and bottom of the flat. Th[e] plastic checks loss of water, yet permit[s] change of air; the cheesecloth distribute[s] the moisture more evenly in the tent an[d] gives a little shade for the cuttings.

After cuttings are planted the propa[-]gation unit can be placed on a bench i[n] a greenhouse or in the window of a dwell[-]ing. In spring and summer it can b[e] placed out-of-doors under a tree. If wel[l] sealed, the unit need not be watered fo[r] weeks or even months. In a window o[r]

Propagating unit described in article is made from greenhouse flat, wire, cheesecloth, an[d] polyethylene film.

Author courte[sy]

greenhouse it should be shaded from direct sun in hot weather.

American Holly

Many individuals, having a deep-rooted affection for the broad-leaved evergreens, have wisely selected the various evergreen hollies as ornamental plants for their property. Today there are a phenomenal number of named varieties of American holly (*Ilex opaca*) being grown. The majority of these do not deserve variety names because they are not sufficiently different from others; none the less, some outstanding varieties are available which are suitable for almost any environment with the exception of the high altitude areas where the winters are especially severe. After close examination, I would select CUMBERLAND and RED VELVET as the two best female plants, and DAVID the most conspicuous male plant in the Holden Arboretum's collection of American hollies. Cuttings of these hollies, as well as of other named varieties of *I. opaca*, can be readily rooted beginning the middle of August. In other words, the cuttings are taken when the current year's growth becomes dark green. Cuttings 4 to 6 inches in length are taken from the ends of the branches. Only three leaves are left on each one. Heavily wounding the cuttings, as with rhododendrons (see page 259), is a generally accepted practice. Draw a sharp knife down the side of the stem at the base for a distance of about 2 inches. Cut only deeply enough to expose the thin, soft, slippery layer (cambium) which lies just under the bark. By treating this exposed, wounded surface with Hormodin #3, faster rooting will take place. These cuttings will take roughly 8 weeks to root, about 2 weeks longer than those of English holly.

Growing Holly from Seed

Although seeds of American and English holly can be collected or purchased they can not be recommended for the amateur. Even freshly gathered seeds, cleaned of their pulp, usually require up to 2 years to germinate. Hollies have separate male and female plants and only the latter produce berries. When raised from seed there is no assurance of the sex of the plants. Moreover, hollies do not "come true," and thus the shape of the leaves, or size and color of the berries will be variable and not necessarily resemble the parent plants from which the seeds are collected.

For those who wish to try growing these hollies from seed despite the difficulties, the best procedure is to stratify them. The seeds are removed from ripe berries and cleaned. They are then mixed with moist peat, placed in a closed jar or deep-freeze bag, and placed in a refrigerator for one year. They should then be planted in a sand-peat mixture. Some varieties may germinate in a shorter time, so it is wise to examine the seed in the refrigerator containers from time to time. If some seeds show signs of germinating, take out and plant. Another method of stratifying is to place the mixture of seeds and peat in a tin can or other metal container in which are punched a few small holes. This is buried 6 to 8 inches deep in garden soil. After a year the seeds are taken up and planted as usual in beds or flats. Seedlings from such a planting may continue to appear over a period of 3 years.

Japanese Holly

In recent years, a number of named varieties of Japanese holly (*I. crenata*) have been developed in the eastern section of the United States. One reason for introducing these new varieties is that the well known variety *I. crenata convexa* has become increasingly subject to the red mite, which turns its attractive glossy, convex leaves into a sickly foliage. Among the many miticides which have been developed, malathion gives excellent control. A comparatively new variety, *I. crenata hetzi*, is slowly finding its way into catalogues. For certain uses this type is superior to the usual *convexa*. Its leaves are much larger and less apt to be disfigured by insects. This new introduction appears to be every bit as

hardy as the original variety and develops into an attractive plant in one-third the growing time. One of the dwarf Japanese hollies that has escaped attention is the slow-growing *I. crenata nummularia.* This plant makes a thicket of short twigs densely crowded with circular leaves. In making cuttings, whether of this pygmy form or any other variety of Japanese holly, take 3- to 6- inch stem cutttings from the plants during the early fall, removing the lower leaves. These cuttings will root exceedingly well without hormone powder when placed under a plastic tent.

Unlike the seeds of American and English hollies, those of Japanese holly do not have to be stratified if they are properly matured and cleaned of their pulp. They should be sown in a mixture of sand and peat, and will produce a high percentage of seedlings in a reasonable time. In attempting to grow *Ilex crenata* varieties from seed it will be discovered that the seedlings vary from the parents, some being desirable, some undesirable.

Growing Rhododendron from Seed

Growing rhododendron from cuttings is discussed elsewhere in this handbook (pages 259 to 260). The recommended practice for raising them from seed is to sow the dust-like seeds thinly on German or Dutch peat in February. Ground sphagnum can be used instead of the peat. After sowing, the seeds are watered with a fine mist or spray; under no circumstances should a forceful jet of water be used. It is beneficial to cover the flat with a sheet of plastic to maintain a moist atmosphere over the planted seeds. As soon as the seedlings appear, the plastic cover should be removed and the flat placed where the seedlings will get plenty of light and where there is good air circulation. Small plantings may be made in plastic refrigerator boxes. After the seedlings appear the covers are removed from the boxes and the same procedure as with plantings in flats is followed. When the seedlings are large enough to be handled they can be pricked out into flats containing a mixture of sand, soil, and peat.

Mountain Laurel

To many people the most beautiful of all flowering shrubs is mountain laurel (*Kalmia latifolia*). Its numerous large clusters of small, saucer-shaped, rose-colored flowers against the deep green, glossy foliage are a familiar sight in June in some regions. A conspicuous variety is *K. latifolia rubra,* which has deep red buds opening to a deep pink. The most unusual variety to date is *fuscata,* with a broad, dark purplish band inside the corolla. Nurserymen are discovering that these scarce varieties of *Kalmia* can now be readily propagated under plastic covering. This opportunity is available to the home propagator as well. Cuttings 2 to 3 inches long of current year's wood should be taken from the tips of the branches during early August. Treated with 1 per cent indolebutyric acid, these cuttings should strike root within 3 months. Mountain laurel seeds should be sown according to directions for rhododendron seed.

Pieris

The last ten years have seen a marke increase in the use of broad-leaved ever greens in Ohio and neighboring states Perhaps it is due to the blight which at tacks the old favorite *Pieris floribund* that *P. japonica* is now being grown i this part of the country. This shrub, sel dom more than 5 feet high, has brilliantl colored new foliage and pendulou racemes of lily-of-the-valley type, wax white flowers during April. There is als a variegated form that is much slower i growth. In taking cuttings of eithe *Pieris floribunda* or *P. japonica,* use th short side shoots during August and Sep tember. Treating them with Hormodi #3 should give a good return of roote cuttings in 10 weeks. Seeds of pieri should also be handled as recommende for rhododendrons.

There is little doubt that any intereste amateur can pleasurably and profitabl increase his stock of many fine broad leaved evergreens by constructing the sim ple propagating unit and using it as ou lined in this article.

PROPAGATING RHODODENDRONS FROM CUTTINGS

A proven method developed from long experience

Lester E. Brandt

The most important consideration in propagating rhododendrons from stem cuttings is the timing, which is difficult to describe, as conditions differ from garden to garden, and even among plants of the same type in different locations in the same garden. The best time of the year in Washington for taking cuttings is from about September 1 to November 1, varying according to local conditions.

Condition of the Cuttings

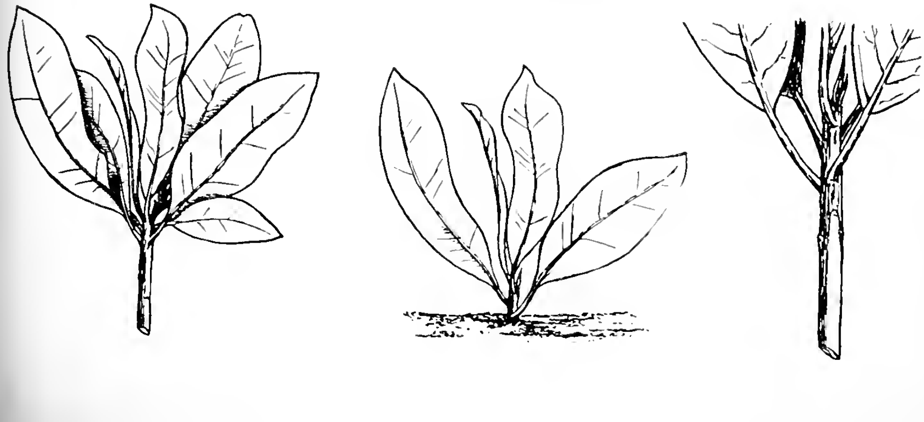
The cuttings should feel fairly stiff, but yielding just a trifle—"springy" is the best way to describe them. The best time to take them is early in the day, as they are then swollen with sap which will form an invisible seal on the ends until they are used. I generally gather around 100 or so at one time, so that they don't have to stand too long. The planting mixture used is roughly 90% peat, and 10% coarse builder's sand. Air-dried Canadian peat is used, as it is readily available here, but German or Danish peat of the same type would no doubt be as good. The peat is well moistened, then spread out, the sand spread on the top, and the two mixed until they are well blended.

Containers

I use western red cedar flats for my cuttings, as I feel that the bottom heat is more even, and also that they are easier to handle. I pack the planting mixture very tightly into the flats, using a tamper. All flats are filled at one time, and put into a bench with lead electric cable, spaced in the usual manner, under them. When the flats are filled and in the benches they are watered thoroughly until water runs through the bottom of the bench. The benches are made of 2 x 8 western red cedar, painted with two coats of cuprolignum. The sides are two boards (16 inches) high, so with 3 inches of sand in the bench, and a flat height of 3 inches, there is 10 inches of air space under the covers.

I used to use glass sash as a cover over the cuttings, with supplemental shading, but I now use a heavy grade of cellu-

Rhododendron cuttings should be 4 to 6 inches long. Enough leaves are removed that none overlap and cuttings are inserted in rooting medium up to lowest leaf (center). If hormone is used, strip of bark 2 inches long is cut away (right) and wounded surface dipped in hormone powder (see page 257).



glas (wire netting coated with plastic). This gives just the right amount of shade, and is much easier to handle. When the flats are well watered and the covers on they will not dry out for some time.

Early Types

When everything is prepared it is usually time to start on the earlier types of rhododendrons, generally the lepidote species and hybrids. Some of these, to be more explicit, are *R. ciliatum, R. cilpinense, R. augustini,* BLUE TIT, BLUE DIAMOND, and PRAECOX. All root quite easily, and are generally ready to transplant by November 1st to 15th. These types do not need any rooting hormone; in fact, if any is used they will rot instead of rooting, as the bark is so thin.

Later Types

After these I start on the midseason hybrids and species, and for these and all of the elepidotes I use a rooting hormone of the strength of Rootone #10. I insert the end of the dry cutting into the Rootone to a depth of about 1 inch, give it a tap to shake off the loose powder, and then force it directly into the tightly packed compost without making a hole or groove and without any after-tamping. After the flat is filled it is heavily watered again, which generally gives enough moisture in the bench to last until the cuttings begin to root, which will be in about 6 to 8 weeks. After the first 2 weeks I lift the sash for about ½ hour in the morning, increasing the time later as the new plants begin to show signs of life.

I set the thermostats so that the heat in the bottom of the flats will be about 72° F. Even the best thermostats vary a trifle, but a range of a few degrees above or below this figure does not matter too much. Practically all *Griersonianum* hybrids are easy to root by this method, and also most other varieties. Those with a large part of *R. arboreum* in them, such as BRITANNIA and EARL OF ATHLONE, can be rooted, but the percentage is generally low. It is not commercially feasible to propagate these by cuttings, but the amateur can strike enough to increase his own stock.

I have successfully rooted large-growing types such as *falconeri* and *sinogrande* but the pith section of these is so large in proportion to the cambium that it is difficult to get a plant to grow and live after it is rooted. Any of the older hardy rhododendrons with a good proportion of *catawbiense, caucasicum,* or *maximum* blood can be successfully increased by this method.

Other Methods

There are many other methods of cutting propagation in use by other growers. The perpetual mist system is very successful, but it needs much more elaborate equipment. There are also othe methods described in articles in garde magazines and horticultural journals. I am continually experimenting with th rooting of difficult rhododendrons, and a I average a 90% strike, including th unsuccessful or partially successful ones I am going to continue my method.

After Rooting

After the cuttings are rooted wel enough to handle they are transplante into open benches in the greenhous into fresh peat moss, no sand. They ar well watered in, and nothing added unti they begin to start growth in the sprin when they are given an occasional water ing with liquid fish fertilizer. I try t keep the night temperature at about 50 F. but during the cold spells it will g lower without any harm. By May or Jun the cuttings will have made at least on growth, sometimes starting on the second and then they are put outside in the ope ground in a partially shaded location. Th usual care is given them, with close a tention to watering, as it takes some tim for the roots to grow out of the pea ball and they must not be allowed to dr out.

I generally have some plants budde the second year after planting out, an most will bloom the third year, with th exception of LODERI, NAOMI, and som others.

Paul Frese

Sasanqua camellias espaliered against brick wall.

SASANQUA CAMELLIAS, AUTUMN TREASURES

How to use and care for these long-neglected but very worthwhile shrubs

Francis de Vos

Although sasanqua camellias have been in cultivation since 1811, only in the last 10 years have they emerged from the shadow of their illustrious cousin, *Camellia japonica*. Some of the reasons for this long period of obscurity are, paradoxically, the same as those for which they are acclaimed today, namely, single flowers, early flowering, and open growth habit.

Landscape Merits

Double and semi-double camellia flowers have long been favored by the public over single-flowered types. Since most sasanqua blooms are single they were passed over along with many of the single-flowering japonicas. In recent years, however, gardeners have come to a greater appreciation of the fact that simplicity is an attribute of beauty.

The fall-flowering characteristic of the sasanqua camellias, which was once a liability, is now considered one of their greatest assets. No other woody plant grown in temperate regions can match the lateness and showiness of their floral display, which starts in late September and continues until frosts cut them down in late November.

The loose open growth habit of many sasanqua varieties was long considered one of their main drawbacks as a garden plant. Along with a greater appreciation for single flowers has come an awareness that the long slender branches clothed in glossy dark green foliage add an artistic touch to the garden that cannot be obtained with most japonica varieties, or with many other plants. There are also compact and low spreading types among the 200 or more varieties of this versatile species being offered by the nursery trade. The excellent evergreen foliage of the varieties WILLOW LEAF and HUGH EVANS makes good background for flowering deciduous shrubs. The varieties CLEOPATRA, ROSEA, NARUMI-GATA, and TANYA can be made into outstanding hedges. Almost all varieties can be effectively espaliered.

Hardiness and Range of Usefulness

Contrary to popular belief the *Camellia sasanqua* is no more and perhaps even less cold-hardy than *C. japonica*. Where a limited number of varieties of the two species have been grown together in areas that experience 0° F. or below, the japonicas have invariably stood up better. However, most of these tests are too inconclusive to permit any definite conclusions about their relative bush-hardiness. There is, however, a marked difference i the bud-hardiness of the two species. O servations at the U. S. National Arbor tum on a number of sasanqua varieties r vealed that temperatures below +18° I so severely damaged unopened buds th they failed to open, or if they did op the flowers were of very poor qualit Most *C. japonica* varieties will withsta temperatures of at least +15° F. in bu without serious impairment of the flow quality.

The present range of usefulness sasanquas for their flowering effect e tends along the Pacific Coast from sout ern California to Washington stat throughout the South, and along the eas ern seaboard to Washington, D. C. Sca tered small but successful plantings ou side this range indicate that sasanqu can be adapted to colder regions if giv some protection. The principal barri to their successful culture from Washin ton, D. C., northward, in areas whe they would be bush-hardy, is the slow rate of bud development. Since high te peratures are necessary for bud develo ment and early flowering, plants in cool regions would not flower in time to esca freezing temperatures. The flowering ti for any particular variety becomes pr gressively later the farther north it grown. A case in point concerns the ou standing double white variety MINE-N YUKI which is highly satisfactory fr Norfolk, Virginia, southward and a bitt disappointment as a flowering shrub the Washington, D. C. area.

Culture

Sasanquas are easy to grow. Their ea of culture is somewhat reflected in t fact that hundreds of thousands are us each year as understock for japonica v rieties. Their vigorous, compact root sy tems assure successful transplanting a rapid re-establishment. Although ba rooted 1-and-2-year-old plants can be r established, best results have been o tained with canned or balled stock.

The basic cultural requirements f sasanquas are a well drained acid s

that is fairly high in organic matter and a surface mulch of such organic material as pine needles or leaves. The "filtered light" beneath high-trimmed pines seems to be best, in that ample light penetrates through for good flower bud production while sufficient shade is provided during the winter months to prevent leaf burning. The sasanqua can, however, be grown in a variety of light situations from full sun where it develops its maximum compactness and greatest flower production, to full shade where it is sparse flowering and usually open in habit.

Camellias are generally planted during the late fall and winter months in the South. For colder regions spring planting seems to be best as it enables the plant to become well established before cold weather sets in. The most important thing to keep in mind about the actual planting operation is that plants should not be set any deeper than the level at which they had been previously growing. Deep planting is one of the major causes of camellia failures following transplanting.

The question of how much fertilizer to use on camellias depends to a great extent on the level of nutrients in the soil in which they were planted and the natural surrounding soil mass. The soils at the Norfolk Municipal Gardens in Norfolk, Virginia, are apparently high enough in nutrients to grow excellent camellias year after year without fertilizing. Since most gardeners do not have such soils, one application of cottonseed meal at the rate of 15 pounds per 1000 square feet (8 to 10 ounces per plant), or a commercial azalea-camellia fertilizer, applied as directed, just prior to new shoot growth in the spring should suffice.

Propagation

Although sasanquas can be propagated from cuttings taken at any time after the new growth has become slightly hardened, best results have been obtained in the Washington, D. C. area with cuttings taken from late July through September. Cuttings treated with root-inducing powders will root within 6 to 8 weeks.

Troubles

The sasanqua is virtually a trouble-free shrub. Infestations of scale, mites, and aphids are usually light and can be controlled by spraying with malathion.

Varieties

Although there are 200 or more sasanqua varieties being offered by the nursery trade, only a small number consistently appear on the recommended lists of growers and collectors. The following varieties are among the most popular at present and are generally available.

*CLEOPATRA — Rose-pink. Semi-double, compact upright growth.

*CRIMSON TIDE—Red. Single with ruffled petals.

*JEAN MAY—Shell-pink. Large, double.

KO-GYOKU (LITTLE GEM)—Pink bud opening pinkish-white. Medium, rose form, double.

MINE-NO-YUKI (SNOW ON THE MOUNTAIN)—White, large, peony form.

NARUMI-GATA (OLEIFERA) — White shaded pink. Large, cupped single.

*ORCHID—Lavender-pink. Large, single with cluster of stamens in center.

*PAPAVER (ROSE PAPAVER)—Soft pink. Large, bell-shaped, single.

PINK SNOW—Light pink with lavender trace. Large, semi-double.

ROSEA — Deep rose-pink. Medium, large, single.

*SHISHI-GASHIRA (BENIKAN-TSUBAKI) — Red. Medium, semi-double to double.

*SHOWA-NO-SAKAE (USUBENI) — Soft pink, occasionally marbled white. Medium large, semi-double to rose-form double.

*SPLENDOR (ROSEA GRANDIFLORA)—Delicate pink with darker pink toward edge. Very large, semi-double.

TANYA—Deep rose-pink. Single.

YAE-ARARE—White edged pink. Large single.

*Varieties that have had sufficient trial at the United States National Aboretum, Washington, D. C., to warrant recommending them for comparable climatic areas.

WINTER-TOLERANT CAMELLIAS

Hardiness tests at Yonkers, New York

P. W. Zimmerman

VARIETIES of *Camellia japonicc* have been growing in my garden in Yonkers since 1930. The first trial was made with cuttings from an unnamed variety growing on the campus at the University of Washington. Unfortunately, the letters concerning the variety were

Camellia japonica variety Z in full bloom in April. Plant has flowered every year for past 10 years.

Photos author courtesy

lost, and I have no information about th history of the plants. None of the exper have been able to identify it. For co venience it is called *C. japonica* var. "Z There are now five seedlings of "Z" whic show as much cold tolerance as the moth plant. The color of the flowers on th seedlings varies from light pink to re Two are late flowering, and the flowe stand up better than variety "Z" whe exposed to direct sunlight. That is a goo characteristic since most camellia flowe fade too quickly when in sunlight.

I believe that when other conditio are favorable, *Camellia japonica* vari ties can stand temperatures as low as 15 F. below zero, but one must admit th under certain circumstances considerab injury can result when the temperatu is above zero. Much of the damage a peared in the spring when the temper ture was above the minimum for the yea

I have grown camellias under a variet of conditions at home and at other place In 1955-56 plants on the southeast side o our house survived in best condition. O the whole, however, it has been my e perience that southern exposures are fr quently harder on plants than other e posures because of the great fluctuatio between night and day temperatures. shaded location in winter is undoubted advantageous. However, the unnamed va riety "Z" has tolerated all conditions t which it was exposed.

These camellias have never been give any special winter protection. No doub they would profit by such protection a is frequently given to boxwood or oth semi-hardy shrubs (see pages 236 an 266).

Of more importance than protection ; to put the plants in the ground early ı the spring so that the roots can be- ome well established before winter. ransplanting can be done at other times uring the year, if great care is exercised nd the plants are well cared for after ransplanting. Nevertheless, spring trans- lanting is strongly recommended.

Mulching is beneficial to nearly all lants, and is of considerable importance o camellias, especially during the first inter or two after transplanting. Either eaves or straw may be used.

Like most other broad-leaved ever- reens, camellias are reported to do bet- er in an acid soil. I have grown them in ots where the soil was very near the eutral point (pH 7) as well as in soil vith pH between 4 and 5. Within my xperience camellias did equally well in andy soils and in moderately heavy oils containing some clay.

Newly planted camellias should be given plenty of water. *Camellia japonica* when well established will tolerate long dry periods.

Camellia plants will compete with other species when planted close to them, but look their best when given room to be featured as individual specimens. They can be pruned to fit into small spaces if desired, but make tree-like shrubs if they have enough space.

Two named varieties of *C. japonica*, ELEGANS (*Chandler*) and KUMASAKA (LADY MARION), which have been growing on the Boyce Thompson Institute grounds at Yonkers for 10 years, deserve special mention. They have tolerated all weather conditions whether growing in direct sunlight or partial shade. They flower profusely in the spring, ahead of azaleas. They are especially good for cut flowers and for landscape purposes. The deep green color of japonica leaves makes this species attractive throughout the year.

Cuttings of several varieties of camellias were shipped to me in November 1950 from the University of Washington Arboretum by Mr. Brian O. Mulligan, for tests in Yonkers. One called CUP OF BEAUTY has survived during the last three winters with only slight damage. The flowers were good in the spring of 1955. For reasons unknown there were no flowers in 1956, but the plants are in fair to good condition. Variety ELENA NOBILE survived but showed winter damage and has not flowered. *Camellia saluenensis* has struggled through three winters but is not worth further testing.

In a letter of May 1956, Mrs. C. H. Sample of St. James, Long Island, states that *C. japonica* var. TRIPHOSA and an unnamed single red flowering variety withstood the 1955-1956 winter without damage to leaves or flowers. She is enlarging her plantings, and the variety testing should be of special interest. The temperatures on Long Island are similar to though not as cold as those at Yonkers.

Cooperative tests are being made in Wilmington, Delaware, and in several different locations here in Yonkers. The reports this year are favorable. The Wilmington tests involve more than 50 plants of several varieties, and the reports are especially encouraging. It appears that *Camellia japonica* will soon be used regularly for landscape purposes in that area.

Of special interest is the hardy collection of seedlings in Yonkers. They are as yet only numbered. Some of them have withstood several severe winters including 1955-56. It is hoped that they will soon be propagated and ready for distribution. There is real promise of hardy camellias for colder climates, and that is what we are working toward here at Boyce Thompson Institute. Further details can be found in my articles in the American Camellia Yearbook for 1953 and 1955. A large number of cold tolerant varieties and unnamed seedlings are also mentioned in these publications.

P. F. Frese and L. L. Baumgartner

A transparent plastic film, so thin that it cannot be seen, is now taking the place of burlap covers and cumbersome windbreaks which have always been the conventional winter protection for boxwood and other evergreens, both broad-leaved and narrow-leaved, in northern states. As a result the winter landscape can be beautiful instead of cluttered with shrouded evergreens.

To apply this film takes only a few minutes for each plant. The material used is a milky white liquid which is sprayed on the plant. It dries quickly, forming a thin film which reduces excessive moisture loss from the foliage.

Nurserymen first began using this product to extend the transplanting season into summer when they found that treated trees and shrubs in full leaf did not suffer from being replanted even in hot weather. Then, newly transplanted rhododendrons, hollies, hemlocks, and other evergreens were also sprayed before transplanting as well as in fall to cut down evaporation in winter. Now many nurseries and tree surgeons offer a regular winter-proofing service for all kinds of woody ornamental plants.

The treatment protects evergreens especially against wind and sun scald and preserves the rich green color of the foliage over winter. Along the seacoast it also protects plants from salt spray. When applied to Christmas trees and cut greens, it prevents needle-drop and keeps greens fresh right through the holidays. The material is harmless to plants and also to pets and humans.

The concentrated solution is put up in small squeeze bottles and also in larger bottles and drums. It is available at most garden supply stores, such as Vaughan's. For use, the liquid is diluted in water. It can be applied with most hand or power insecticide sprayers when temperatures are above freezing. Equipment should be washed with a detergent immediately after use.

Boxwood hedge, not treated or covered for the winter, died back at the top and all foliage showed sun scald.

In the same garden another boxwood hedge which was given a plastic protective coat came through the winter perfectly with no sign of injury.

Gottscho-Schleisner

Light shade beneath tall trees is ideal for camellias.

Growing Camellias in The Northwest

Including suggestions on propagation and landscape use

Helen G. Buzard

IN the Northwest outdoor camellia growing is chiefly limited to the Puget Sound area where the climate is mild. While camellia plants will survive the more severe winters of other sections the flower buds are generally killed, and only the most ardent camellia devotee persists in growing them under these conditions. East of the Cascade Mountains where winter temperatures drop well below zero and summers are hot and dry, camellias are "off limits."

Exposure

In the Puget Sound area, most gardeners consider camellias as easy to grow as any of the other shrubs and trees. Preferably, camellias should have partial shade. Overexposure to bright sun causes flowers to burn, and leads to poor foliage color.

Where shade is too heavy, bud set is poor and damage from frost is more severe. However, throughout our area one may see camellias planted with little regard to sun and shade, and except in extremely poor situations they grow satisfactorily. In most gardens here they are planted for their landscape effect in association with other plants, rather than for any special needs of their own.

Good drainage is essential, especially in this climate where winter rains are heavy. Where drainage is poor it can be remedied by channeling excess water away, or by planting the shrubs in raised beds.

Soil and Fertilizer

Soils in western Washington have a natural acidity that is suitable for camellias. The addition of peat moss, leaf mold, or rough compost at planting time improves the soil structure which is often either too heavy or too light.

Barnyard manure is preferred as a fertilizer by most camellia growers. Lacking this they use fish meal, cotton seed meal, tankage, or an acid commercial fertilizer. Fertilizers should be put on early in the season so the resulting growth will mature before the first frosts.

Watering

Rainfall is sufficient to keep plants healthy for seven to eight months of the year. During four or five summer months camellias, if watered along with the rest of the garden, will get enough water to keep the root areas moist. In this land of Sound and lakes the humidity seldom drops low enough to be detrimental to camellias.

Pests

Camellias are perhaps freer of insects and diseases here than in any other place where they are grown. The strawberry root weevil, prevalent in this area, attacks the roots of all plants, camellias included, and if not controlled may girdle the bark at the base of the plant. Soil insecticides like lindane and aldrin are bringing the weevil under control. These compounds can be most easily applied as a drench around established plants, using concentrations and amounts recommended by the manufacturer. Care must be taken no to injure the shallow roots of the plant if lindane or aldrin are cultivated int the soil. If used before planting, work i deeply as the soil is spaded or rototillec Application can best be made in th spring, and is usually effective for 2 or years.

Pruning and Mulching

In our comparatively short growin season, camellias average only one growt cycle a year. An occasional second growt at the top should be cut back; other tha this very little pruning is necessary. Mos gardeners shape their plants when the cut flowers.

Mulching is a general practice in ga dens in this area. Camellias receive mulch along with the rest of the garde Peat moss, leaf mold, or sawdust are th materials most commonly used. One c the best mulches is a combination of saw dust and barnyard manure.

During an open winter camellias can b transplanted from October to April. How ever, it is better to plant them as earl in the fall as possible or wait until ver early spring. Fall planting can be do only in mild climates such as ours. I colder regions spring planting is a mus

Use in Plantings

Camellias are used in landscaping he much as they are in other areas. Th oldest plants were used as lawn spec mens, a type of planting that has go out completely. Most camellias are us in shrub borders, some are used as hedge and some are espaliered against walls a fences. There are a few camellia garde where they are planted together and aw from other plants.

It is as impossible to predict the pe formance of a camellia in Washington it is in any other section of the camelli growing world. No plant is more va able. On occasion they may change colo form, and size from one area to anothe even from one year to another.

Blooming Time

Occasionally in the Northwest, an ear variety such as Daikagura, High Ha or Nobilissima will bloom at Christm

f the winter is very mild. However, there s seldom more than a smattering of bloom until late March. The peak of the season comes in April and by mid-May flowering s over.

Varieties

Any list of varieties will reflect the preferences of those compiling it. Ask a dozen growers for their favorite dozen camellias and you'll get a dozen dozens. A few, however, will be named on most lists.

All of the J. C. Williams hybrids of *C. saluenensis* which are generally available are on the most favored lists including J. C. WILLIAMS and MARY CHRISTIAN.

Any of the sasanquas which bloom early enough to escape the first frosts and have flowers with enough substance to withstand rain are popular and worth growing. Even these vary in their performance, depending on locality.

Reticulatas are not hardy enough to grow outside except in some very favored gardens, or in cool greenhouses.

The list of japonicas is long. Tops on all lists is LADY CLARE and its variegated form ONIJI. Outstanding in size, form, color, and performance, it blooms as long as 3 months with flowers that last a week to 10 days on the plant or picked. With the usual confusion of names it is often sold as GRANDIFLORA ROSEA.

AUBURN WHITE (a name established in this area for a Japanese import that is variously called MADONNA, BREHM'S MADONNA, and OSTBO'S #4) is a large single white, showing a tint of pink, with crinkled petals and exceptionally fine texture.

FINLANDIA and its varieties, including a fine pink developed by Barney Goletto of Milwaukie, Oregon, called MONTE CARLO.

FRED SANDER, alias FIMBRIATA SUPERBA, the name in common use here.

ELEGANS (*Chandler*) and the new forms C. M. WILSON and SHIRO CHAN.

TRICOLOR (*Siebold*) including the red and white forms.

DAITAIRIN, a general favorite though it doesn't always show petaloids.

PINK POPPY, a late variety that performs with remarkable consistency.

VILLE DE NANTES, unfailing in some gardens, variable in its performance in others.

FLAME, unaffected by adverse weather conditions.

BERENICE BODDY, performs best in cold weather and is better here than where it originated in California.

FLORENCE DANIEL, a miniature having exceptional perfection of form.

KUMASAKA, variable in flower form but consistent in generous flower display.

University of Washington Arboretum

Camellia japonica BERENICE BODDY.

CAMELLIAS IN CALIFORNIA

. . . suggestions applicable to many regions

William E. Wylam

California is a big state and the sections where camellias may be grown are many and varied, both as to climate and soils. However, in general, these sections may be grouped into two divisions—the cool, humid coastal region, where there is a minimum variation between day and night temperatures, and the interior valleys which have a daily wide range of temperatures and which are hot and dry in the summer. It might be well to note at this point that camellias in coastal areas need far less shade than those planted in interior valleys.

Camellia PURITY at corner of brick wall provides evergreen accent for border of summer annuals.

Grossman

Native Habitat

In their natural habitat, camellias are usually found as secondary growth on wooded slopes, in areas of considerable rainfall. Soils are well drained and have an acid reaction. If similar conditions are provided they respond most gratifyingly.

Correcting Alkaline Conditions

The Central Valleys and Southern California are regions of light rainfall and in many sections the soils are alkaline. In some areas the water is also alkaline. To counteract these conditions many growers use a large percentage of peat in their soil mix. Soil sulfur is sometimes used to correct alkalinity, as are ferrous sulfate and magnesium sulfate; iron chelates or "stabilized iron" are also used. Aluminum sulfate is not recommended for California conditions because of its residual salts. Perhaps the best method of preventing damage by alkaline and saline conditions is periodically to leach the soil by heavy flooding to remove the excess alkaline salts. However this also removes some of the necessary nutrients which need to be replaced.

Culture

In growing camellias there are three practices which must be followed to secure optimum results. First, and possibly most important, is shallow planting. The feeder roots should be just below the surface of the soil. Second, the soil should contain a large percentage of humus. This helps in supplying needed acidity. Th

third requirement is good drainage. Nothing will kill camellias as quickly as soggy soils which prevent the roots from obtaining needed oxygen.

Various organic fertilizers such as cotton seed meal, castor pomace, and the commercial "organic plant foods" are largely used. Many follow the practice of fertilizing lightly at intervals of approximately 6 weeks, from the middle of April to the end of August. Fertilizing during the fall and winter is apt to induce tender growth which may be injured by frost.

By selecting camellias that bloom at various seasons, Californians are able to enjoy camellia flowers from September to late May. Some camellias seem to do equally well in all sections whereas others are superb in one section and mediocre in another. As a general rule, MATHOTIANA ALBA and the other late formal types are best adapted to cool, humid areas, while LINDSAY NEILL and similar camellias are apt to have small blooms in such areas but are spectacular in the interior valleys.

Varieties

Japonicas still predominate and among those which are popular in many areas are several which should be listed by "families" rather than as individuals. An example of this is the Donckelari Group which includes the various forms of DONCKELARI (*Siebold*) — ENGLISH, SOUTHERN, TALLAHASSEE, TEA GARDEN, etc.—EUGENE BOLEN, EUGENE LIZE, LADY KAY, VILLE DE NANTES and possibly other cultivars. These "families" include the Daikagura Group, the Elegans Group, the Finlandia Group, and the Herme Group. Among other popular camellias are:

ADOLPHE AUDUSSON—turkey red
ALBA PLENA—white
C. M. HOVEY—carmine, some white splash
DEBUTANTE—carmine rose
GIGANTEA—crimson, splashed white
GLEN 40 (COQUETTI)—turkey red
GRANDIFLORA ROSEA—carmine rose
KUMASAKA—carmine
LADY CLARE—carmine rose
LALLAROOK — carmine, some marbled white
MAGNOLIAEFLORA—white flushed pink
MATHOTIANA—carmine
NAGASAKI—carmine, variegated white
PURITY—white
WHITE EMPRESS—white

It is true that many Californians know only of the japonicas and regard camellias simply as a source of exquisite cut flowers or as single specimen plants rather than as superb landscape material. However, as the public learns of the hardy sasanquas and the spectacular Yunnan reticulates and other newly discovered species, and their hybrids, a rapidly growing interest in landscaping with camellias is becoming evident.

More and more people are becoming aware of the value of the beautiful camellia foliage, the character of which is such that it readily adapts itself to any situation, from a formal planting to the exotic tropical effects created as a setting for the bold architecture currently popular.

BROOKLYN BOTANIC GARDEN RECORD

PLANTS & GARDENS

WINTER
1956-57

The
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Guide to
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ks and Articles
or Gardeners

NEW SERIES
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PLANTS & GARDENS

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NOTICE OF CHANGE OF ADDRESS AND ALL OTHER CORRESPONDENCE SHOULD BE ADDRESSED TO:
BROOKLYN BOTANIC GARDEN, BROOKLYN 25, N. Y.

Winter ice glitters on trees in the Rock Garden at the Brooklyn Botanic Garden.

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Winter 1956/57

Once again our Editorial Committee has made its annual selection of the "articles-of-the-year." This is the twelfth season we have combed over the non-technical gardening and horticultural literature, looking for gems that are in one way or another of lasting interest or significance. Our Committee admits a certain degree of bias in its selections, bias toward articles that present usable new methods or information that everyone should know about, or articles that bring important subjects up to date. There are also stories that tell of personal experiences which may give readers new ideas for their own lives—as well as for their gardens. The charming account by Chiang Yee, famous "Silent Traveller" from the Orient, has never before appeared in print. All who know his books will read it with special delight.

In assembling this year-end issue of PLANTS & GARDENS, the Brooklyn Botanic Garden pays special tribute to authors and to the magazines in which the selections first appeared. This is our way of awarding "intangible Pulitzer Prizes" in the gardening and horticultural field, and we take great pleasure in thanking all concerned for their warm cooperation in making it possible.

Here at the Botanic Garden a fine new year is getting under way—more about this later. Meanwhile, here is something to think about. It may be a proverb from the Far East, or it may be original. I do not know. One of our senior gardeners, of Oriental ancestry, is quite a philosopher. A few days ago he mentioned that "patience is often said to be necessary in gardening." He thinks differently. "Patience," said he, "is needed only by those who don't enjoy what they are doing. If one enjoys doing something, it doesn't require patience." How right he is.

As you garden your way into the new spring and summer, may your contributions to happiness be many—both for yourself and your friends.

Sincerely yours,

George S. Avery, Jr.

Director

Courtesy Sunday Sun Magazi

Carmen Gianforte grows seven thousand hollies and other plants in his backyard nurser

BOY WITH A HOLLY-GREEN THUMB

Already an expert on the subject, this youngster takes his holly as seriously as the professionals do

Gray Johnson Poole

Condensed from the Baltimore *Sun*, September 23, 1956

MEMBERS of the Holly Society of America, Inc., were somewhat surprised, to put it mildly, when in 1954 their semi-annual meeting was attended by a little brown-haired, black-eyed boy. A bona fide, paid member, the boy was Carmen Gianforte. He said he was a junior high school student, and he asked to be called Butch.

Though he will not be 16 till December, Butch has been planting, propagating and growing holly for four years. He now has 40 varieties and about 7,000 plants, ranging in height from 2 inches to 6 or 8 inches. It will be many years before these slow-growing plants are trees. No berry-laden boughs can be ha vested until after Butch has finished co lege, and he won't graduate from hi school until February of 1959.

Crop timing is not what concer Butch, however. He's a propagation e thusiast. He hopes to go to an agricu tural college and then become a propag tion specialist, perhaps "like Jim Wel of England. He's the greatest."

At last spring's Baltimore Science Fa sponsored by the North Baltim Kiwanis Club and the Johns Hopki University, Butch won an honorable me tion for his display of holly grown w artificial light and heat.

In the basement of his home he has a dirt-floored room where he experiments with an artificial light and heat process that not even many professional nurserymen use. Electric cables and fluorescent lights sandwich the experimental plants on table shelves. Heat pipes run under the tables and light tubes stretch across the very low ceiling.

Here Butch intends to do intensive experimenting next winter. He will make detailed notes on test plants and trial methods. He wants to know how many leaves should be removed from tiny holly plants; what heat is required under the soil for the best growth. He will record the results of staggered watering dates and hormone feedings, under controlled conditions.

In cultivation and in the practical mechanics of mass-gardening he has been extremely inventive. His outdoor nursery occupies several acres beyond the lawn of his home. He cleared brush and small trees several years ago to make room for his seedlings. Neat rows of tiny azaleas, evergreens, Japanese maples and several other kinds of plants now grow there.

Seedlings are watered from overhead by a Rube Goldberg contraption he built. But even he doesn't quite trust the temperamental system of pipes and remote-control taps. Visitors are warned to "Stand back!" until he sees which way the water is going to spray.

Weeding around rows and rows of pots has been a back-breaking, time-consuming job, so, during vacation this year, Butch experimented with a weed-control base. Under test pots, he stretched several feet of building paper, layered on top with sand to hold moisture.

His theory, which seems to be working, was that weed seeds couldn't germinate under the paper without air and that those hardy weeds which did survive and sprout could not push up through the tough substance. If the potted seedlings grow satisfactorily on their light sand base, Butch intends to stretch building paper under all his flats next spring.

Like all gardeners, Butch has his problems with the elements—heat, cold and water. In the last couple of years he has rooted thousands of azaleas. "Rooting cuttings," he says, "is one of my favorite branches of propagation." He did so well with rooting that this spring he had 9,000 small azaleas and 11,000 tiny ones.

It was apparent in the early summer that more room was needed for plants, so Butch and a friend cleared another half-acre of woodland, then relieved congestion in the original site by moving hundreds of pots. For days they transported plants four at a time with a gadget Butch had read about; made from a pair of pliers with an expandable handle, this will support two five-gallon cans filled with plants and soil.

One day in midsummer the laborious chore was finished. Evergreens, holly, box and rhododendron stood in neat rows in the new section. The next day the entire area was flooded out by a July torrent. Hard work saved most of the plants, but repotting took weeks.

With his father's help, Butch is building his first greenhouse. Copying a commercial greenhouse he saw in the North, he has dug trenches three feet down for a subterranean walkway. Potting tables will be waist high at ground level. The sides of the greenhouse will be polyethylene and the shading, a new screening.

Butch works in summer from 8 to 4. During school terms he tries to be home from City College and at work by 3:30.

Traveling to study holly and to get new varieties is never any trouble for Butch. Three times during this summer's vacation he went to the holly orchard owned by the Society's president, Clarence Wolf, at Millville, N. J.

By the time Butch finishes college, his seedlings should have grown into salable stock for a nursery. But he will run a nursery only if it is an economic necessity. His ambition is to root, graft, improve growing conditions, and increase varieties—in short, to be an expert on propagation.

A seedsman unfolds the new "magic" in flowers known technicall as F_1 and F_2 and explains the new horizons which will open when you

DISCOVER THE F_2's!

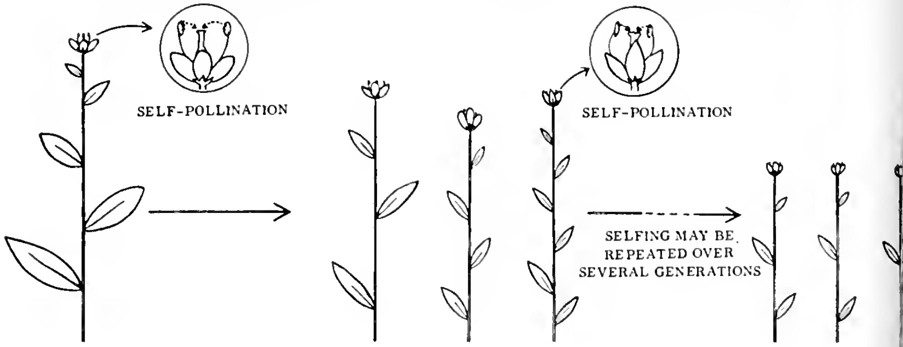
Howard Bodger

Condensed from *Flower Grower,* January, 1956

URANIUM 236 is a scientist's designation which has become widely known and recognized because of its vast importance in human affairs, and in a similar way (without the ominous overtones) the genetic symbols F_1 and F_2 have escaped from the plant breeders' lingo into public use.

There's nothing mysterious about these symbols—they simply designate the generation, like father, son and grandson. F_1 means first filial generation and has come to be accepted as the first generation following the controlled cross-pollination of inbred lines. F_2 is the second generation, harvested from the F_1 crop.

While there is no mystery about the symbols, there is plenty to wonder abou in the process of hybridization itsel About forty or forty-five years ago ge neticists discovered that if corn were in bred for several generations the line were weakened but became extremely uni form. All the plants looked alike i height, color, maturity and general pe formance. But if two of these inbre lines were crossed then something re markable happened. The offspring i the next generation, the F_1, was large more vigorous and decidedly more pr lific than either of the parents or t open-pollinated strain from which the i breds had come. The phenomenon w called hybrid vigor.



The first step in establishing an inbred line of plants is to self-pollinate plants as sho diagrammatically at left. The plants grown from seed resulting from this "selfing" often inferior to the parents and usually show some variation. When these offspring blo they are again self-pollinated, the breeder often using only certain selected ones. This be repeated a number of times (indicated by broken arrow). After enough repetition point is reached at which the decline in vigor of the offspring ceases and they become v uniform. Further selfing results in offspring which are just like their parents and one another, and we say we have an inbred line which breeds true.

F_1 Hybrids

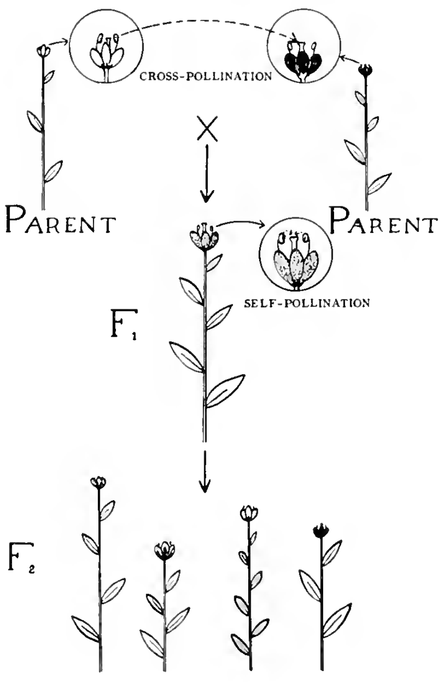
From this example of a genetic principle, commercial applications came first in vegetable crops such as cucumbers, melons, tomatoes and onions and, more recently, in flowers. The recent strong interest in petunias over the country results from the introduction of F_1 hybrids of plainly evident superiority over standard lines. The All-America Selections are heavily loaded with petunia entries, and some outstanding new F_1 hybrids, such as BALLERINA and COMANCHE, have already received high awards.

What Comes After F_1?

F_2 comes next, of course, with an endless line of generations off into the future. But it isn't as easy as all that, and farmers learned rapidly that in the case of hybrid corn planting even the planting of the second generation was not good practice. The hybrid vigor was reduced and uniformity was lost. Succeeding generations became no better than open-pollinated strains, and were often worse.

The Mendelian law, which governs the way in which a hybrid will separate into its components in the second generation, is just as reliable as the law of gravitation when the characteristics of the inbred parents are thoroughly known. There is no advantage in knowing how many corn plants in the F_2 will have green silks and how many red silks. It is a lot more important to know that uniformity and yielding capabilities are lessened. But in petunias, on the contrary, it is extremely interesting to know just what percentage of the second generation will bear pink flowers, what percentage rose, what percentage variegated, and so on. Here the segregation is not a disadvantage, but a great breeding tool.

For instance, if a stable inbred with a pink flower is crossed with a similar inbred with a blue flower, the resulting F_1 will have uniformly magenta blooms. Seed saved from this F_1 will segregate in the F_2 to provide one-fourth pink flowers, one-fourth blue flowers and one-half



When two different inbred lines (the plants marked "parent" in diagram) are cross-pollinated, their offspring are called the F_1 plants. They often are much more vigorous than either parent, a phenomenon called hybrid vigor. The F_1 plants are usually very uniform, and in such things as flower color, leaf shape, habit, etc. they may resemble either parent or be a blend of both.

Self-pollinating the F_1 plants gives the F_2's. They are usually less vigorous than the F_1's, but the most interesting thing about them is that they are extremely variable. Most of them do not resemble their F_1 parents or even the original inbred lines, but show all kinds of colors, markings, shapes, etc. Even though these F_2 plants may not resemble the original inbred lines, by careful experimenting the breeder can discover which parent lines to use to give F_2's that produce desirable mixtures of flower colors, shapes, etc.

flowers of varying shades of magenta, from near pink to near blue and all of the many degrees between.

It happens that magenta is a color not popular in petunias so the wise breeder avoids combinations which will produce this result. He can do this in the F_1 and in the F_2, but his control is lost after that point; since magenta is a normal species color in petunias and is dominant over other colors, this is the shade that appears in the F_3, not exclusively, but heavily enough to make a very unpleasant mixture. This is true even though not a single magenta flower appears in the inbreds, F_1 or F_2.

New to the flower garden, and an application of the breeding techniques just discussed, is the F_2 hybrid called CARNIVAL petunia. This petunia is of the grandiflora type, with 80 per cent of the blooms about 3½ inches across and 20 per cent slightly smaller. Petals are waved, ruffled or fringed, and have the heavy substance and durability of the grandiflora type.

In this new petunia is a perfect example of science in the flower seed industry, for this is an application of principles previously ignored or unknown. Mixed colors in petunias are normally made up of blends of different petunia varieties. They must be grown separately and blended to form the mixture or the incidence of magenta becomes overwhelming. But in the case of CARNIVAL the mixture of colors is formed by the planned segregation of F_1 hybrids which are bred and grown specifically for their effect in the next generation.

There are only a certain number of colors in the petunia world so far as distinct varieties are concerned, and these were the limit of a mixture until this new application of the hybrid principle was made. Now the breeders can obtain an almost endless series of shades and tones, and in the case of CARNIVAL it is possible to count at least twenty colors in a moderate-sized planting. They include blue, white, crimson, rose, scarlet, salmon, salmon-pink, carmine, brilliant rose, light pink, red, rosy lavender, cream-pink, and variegated, starred or edge combinations of white and rose, white an pink, white and blue, plus numerous in termediate shades for which no commo name is applicable. This extreme colo range (without a magenta in the lot) i one of the great advantages of th CARNIVAL strain.

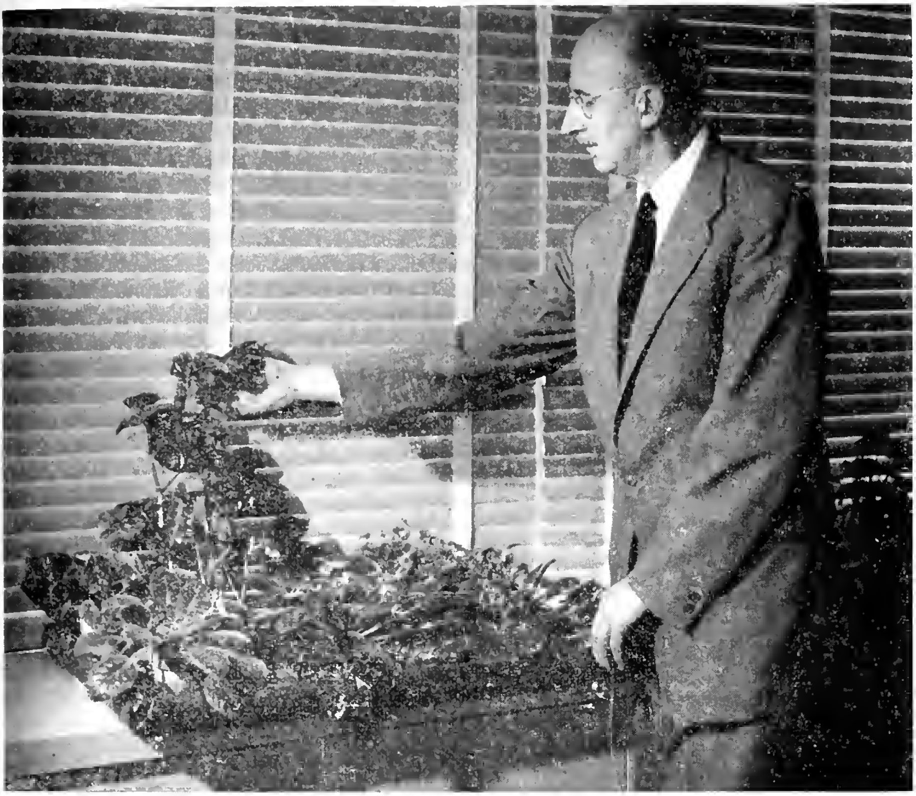
Uniformity of plant type is one o the strong points in an F_1 hybrid. Eac plant looks like its neighbor and can b relied upon to perform in the same way Where a formal border is planned an a single color is desired, then an F_1 fill the bill. But some like mixed colors i the garden, and it is prohibitively ex pensive to buy a separate F_1 for eac color desired, even if there were a com plete color range available. Here the F has another advantage.

Cost of F_1 and F_2 Seed

Even at the lowest wholesale pric grandiflora petunia F_1 hybrid seed worth more than six times its weight i gold, since every bit of it is hand polli ated and there are approximately 300,00 seeds to the ounce. But seed harvest from the F_1 to make the F_2 crop do not require hand pollination, and the co of production is about the same as f the regular open-pollinated grandiflo varieties. Translated into home gard terms this means that you can expect pay anywhere from one dollar up for infinitesimal pinch of F_1 seed, while you get a respectable quantity of CARNIV F_2 for a fraction of that cost.

There are other flower classes up which countless hours in crossing and i breeding and many a long run on t calculating machine will someday ha an effect.

Long-term breeding programs, carri on largely by seed growers who can affo heavy investment in the future, bring t microscope, atomic radiation, colchici and electronic calculators into the flow garden. These growers must put th efforts into the kinds of flowers wh are popular with the gardening pub and they have to know what things needed.



African violets and many other house plants thrive in Mr. Farnham's vermiculite-filled trays.

TRAY GARDENING YOU CAN DO

Many house plants will thrive in simple home made plastic trays

R. B. Farnham

Condensed from *American Home*, March, 1956

IMAGINE a shallow tray of mature foliage or flowering house plants—as intriguing as a tray of canapés and far more beautiful and lasting! Or, better, don't merely imagine it—have one! It's easy. And in it you can grow plants without pots and enjoy natural beauty indoors without any bulky containers of soil.

Here is, indeed, a fundamental and most revolutionary advance in house plant culture, offering advantages to both the indoor gardener and the interior decorator. It can be adapted to any space

and decor. And it greatly simplifies the care of the plants, providing around their leaves a cool, moist atmosphere that they need so badly and which is usually lacking in the average home. The broad, shallow rooting area insures abundant aeration. The roots are not matted against a flower-pot wall where they are subject to extremes of aeration, moisture, temperature, and available nutrients; any root crowding occurs first on the bottom of the tray, which is the last part to dry out, lack nutrients, or fluctuate in temperature. So plants grown in trays tend to stay healthy and handsome longer.

Tray culture was evolved over the past five years in the large windows of the Horticultural Society of New York, where difficult growing conditions had given inferior results. The tray of moist vermiculite lessened the heat of the brief midday sunshine which had previously injured plants that were growing most of the time with too little sun. It enabled them to endure unharmed the Friday-to-Monday periods of too-high temperature, when the air conditioning was shut off. A potted *Veltheimia* standing in a tray actually matured seed and sowed it in the vermiculite where it germinated and grew! An African violet cutting thrust into the vermiculite rooted, thrived, and bloomed all summer where, previously, plants had suffered sun-scalded leaves. In fact, everything we have tried has thrived except the aluminum plant (*Pilea cadieri*), which seems to do better in a pot where it can be kept drier.

Nine trays in the Society's offices (the one on page 281 is a year old) support a healthy collection of begonias, African violets, rosary vines (*Ceropegia woodi*), pick-a-back plants (*Tolmiea menziesi*), philodendrons of several kinds, cape primroses (*Streptocarpus* spp.), spider plants (*Chlorophytum capense*), and cape grapes (*Cissus capensis*), all growing in vermiculite.

Care

Construction and planting details are explained in the photographs. Care of the trays is just as simple. Whenever the surface of the vermiculite is no longer

HOW TO MAKE A WATERTIGHT WINDOW TRAY

1 Nail 1- by 2-inch strips together to make a frame to fit the area available. No bottom for frame is needed if a thin board is slipped under tray when it is to be moved.

2 Tack Koroseal or a similar heavy plastic (available at most department stores) to the frame. Cut plastic 10 inches longer and wider than frame to allow for turning under

moist, apply enough of a *very dilute* solution of plant food (instead of plain water) to remoisten all the surface and cover the floor of the tray not more than one-quarter inch deep. This may mean twice a week, or more or less often, depending on the number and size of the plants in the tray and the temperature and dryness of the air. Even if too much water is applied, damage is not likely, for even an inch of water in vermiculite can contain enough air to keep the roots of most plants from drowning. However, repeated flooding will injure the roots of the more sensitive kinds, as you'd see by the foliage the week following.

Almost any one of the complete soluble fertilizers on the market is satisfactory for most of the common foliage plants—provided the solution is kept weak by using less plant food than is directed on the package. For two years I have added only a level quarter-teaspoonful of soluble 10-10-10 analysis fertilizer to each gallon of water. Insist on a fertilizer that lists its constituents on the label, and select one with about equal parts of nitrogen, phosphoric acid, and potash, and the fewest compounds containing chlorides and sulphates.

When a plant threatens to become top-heavy, cut off the upper section, dust the cut-off end with a root-inducing powder, and stick it into the vermiculite in another tray to grow into a new plant. A handsome mature plant in a pot can be simply stood on the floor of a tray. Here it seldom needs water oftener than the tray itself, and its flourishing condition will show how it appreciates the cool, moist air around its leaves.

Light

Remember, though, that plants will not stay healthy, even in these trays, without enough light. So the location must be either in a window or adequately lit by cool fluorescent light (perhaps combined with some incandescent light).

Even less than wholly adequate light will prolong a plant's beauty and cut down the frequency of needed replacements. Incandescent light alone will help,

Photographs courtesy of American Home

3 Fill the finished tray with coarse, insulation-fill vermiculite, which can be bought at builders' supply stores. Do not use the fine grade sold by garden stores.

4 Arrange plants in the watertight tray after first washing roots free of soil. Spread roots on the bottom of the tray, cover with moist vermiculite and firm gently.

but its greater heat tends to encourage the growth of injurious red spider mites. A 100-watt bulb in a reading lamp will give 75 foot-candles of light to a plant on a table beneath it, and this is enough to keep most foliage plants healthy for a year or more, especially with light-to-moderate watering. From 200 to 500 foot-candles will grow African violets if they are well cared for and if the air is not overheated.

The following table, developed by R. L. Zahour of the Westinghouse Lamp Division, shows how distance affects fluorescent light intensity. It assumes a 4-foot industrial-type fixture with two 40-watt fluorescent white tubes and a reflector suspended lengthwise above a 2- by 4-foot bench or table. Column 1 gives the height of fixture above center of bench; column 2 gives foot-candles of light at center of bench; column 3 gives foot-candles along sides of bench. The plants listed are those reported most satisfactory, given 16 hours of light each day.

Height above bench (inches)	Foot-candles, center of bench	Foot-candles, sides of bench
4	750 (orchids)	600
5	600	500
6	500 (African violets)	400
7	450	350
8	400	325
9	350	300
10	325	280
12	300	250
14	250	200
16	225	180
18	200	140
20	180	115
24	110 (foliage plants)	100

CONTROL FOR POND SCUM

Reprinted from *The Begonian*, October, 1956

FOR the first time since it was developed for recreation and irrigation purposes by the late E. J. "Lucky" Baldwin, the five-acre spring-fed lake at the Los Angeles State and County Arboretum in Arcadia has just been successfully cleansed of algae (scum) by use of a special chemical. Almost completely covered with a heavy coating of algae, the surface of the lake was made crystal-clear within a few days after spraying with a newly developed fungicide known as Phygon-XL. The Arboretum lagoon alongside the famous Baldwin Queen Anne Cottage and the Hugo Reid adobe now provides mirror-like reflection of its lakeside tropical trees and foliage. Arboretum Director William S. Stewart says the first attempt at spraying the lake with algae-killing powder apparently has provided the Arboretum with a permanent method of keeping the lagoon clear of the unsightly green growth which has marred its beauty.

Phygon-XL, first introduced in 1943, is now used as an algicide in lakes of Wisconsin, where it is said to be one hundred times more efficient than other algicides in killing water weeds. It also is being used in New Jersey and in industrial regions of New England. First use of Phygon-XL in California was in irrigation canals and later in ponds. It has cleared water for fishing, swimming, boating and irrigation. So far, the anti-algae chemical does not appear to have harmed the large stock of fish in the Arboretum lake, which is one of the historical water spots of Southern California.

Homeowners with small garden pools can control surface algae by spraying the surface of the pool with Phygon-XL powder dissolved in water, used at the rate of 1 ounce per 250 square feet of surface area of the pool.

—Louise Cramer

Photographs courtesy of author

This rotting log lies on the forest floor. Fungi and other organisms speed its natural decay, making room for new generations of trees such as the hemlocks shown growing upon it.

FUNGI—

FRIENDS OF THE FOREST

Mushrooms and toadstools—saprophytic fungi that live on dead plant materials—are among the most interesting plants in the world. Some have great beauty, many are edible, and all are useful.

Donald H. Clark

Condensed from *Audubon Magazine*, September-October, 1956

FORESTERS may raise their eyebrows and brand as heretical the suggestion that fungi are their friends. Colleges of forestry teach identification and control of tree-destroying species, and it's a matter of record that almost ten per cent of our American forest crop is killed, damaged, or degraded by fungus attacks. Few foresters, however, give serious thought to the fact that we wouldn't have any forests if it were not for omnipresent fungi which reduce dead timber and forest litter to essential humus on the woodland floor.

Without the sanitary services of fungi, the original forests which immigrants found on our continent would have accumulated forest debris from decade to decade until the huge unaltered woodpile was ignited by lightning or by an aborigi-

The fragile fungus, *Mycena epipterygia*, "specializes" in disintegrating fallen branches and leaves.

nal campfire. The resulting conflagration would have reduced the forest and its topsoil to a sterile desert!

While certain fungi are justly accused of killing trees, those attacks are mostly on over-mature, decadent stands which now are diminishing in volume and importance as we advance to younger, managed forests. And under future forest management, tree-killing fungi should be reasonably controlled.

Even under the most competent management, however, forests will need fungi, which, with the help of bacteria and insects, will continue to convert stumps, tops, leaves, fallen limbs, and cones into the blanket of humus which protects tree roots, retards water runoff, and eventually becomes integrated with mineral soil.

For every destructive species there are at least a score of saprophytic fungi which constantly produce mulch from useless wood. Some species act in a dual capacity, as does *Armillaria mellea,* a destructive tree-killer but also a disintegrator of stumps and of dead and useless timber. Its cousin, *A. ponderosa,* is a saprophyte which lives on decaying wood, and incidentally produces a choice edible mushroom that grows commonly in Pacific Northwest coniferous forests. So abundant is this esculent product of forest waste that local Japanese collect and sell it by the ton each year.

The coral fungus (*Hydnum coralloides*) also doubles as a forest sanitarian and food supplier. Its saprophytic activities, especially in dense Engelmann spruce forests, accelerate the decay of stumps and dead roots, of which the end product emerges in the form of large tufts of interlacing edible branches. Competition for this forest delicacy is so keen that, unless it is collected within a few hours after

This minute mushroom, *Collybia albipilata,* is so particular about its food that it refuses to grow on anything but fallen cones of Douglas fir.

The strange-looking morel, *Morchella esculenta,* is one of the most delicious of edible mushrooms.

The ruffled *Daedalea unicolor* is a champion natural stump-remover, given time and sufficient moisture.

its emergence, insects and rodents will have beaten the human mushroom hunter to the draw.

The fruiting bodies of nearly every forest saprophyte, in fact, furnish food for some forest habitant—bear, deer, rodent, bird, or insect. One exception is *Daedalea unicolor*, a rapid and efficient destroyer of hardwood forest debris, which is too tough to be eaten by man or beast.

The amanitas are instinctively avoided by forest birds and other animals because of their extreme toxicity, although they're occasionally eaten with fatal results by mammals of the genus *Homo.**

The fruiting bodies of two species of *Mycena*, *epipterygia* and *galericulata*, are unbelievably fragile, but each species is a potent destroyer of waste forest wood. The latter works on decaying wood only, while the former specializes on dead branches and masses of fallen leaves. Another fragile wood-destroyer, which forms huge clusters of fruiting bodies on old stumps, is *Coprinus micaceus*. Few forests in the United States are without its sanitary services.

Bacteria and insects materially assist saprophytic fungi in decomposing forest litter. Wood-boring beetles carry fungus spores into dead tree trunks and stumps. On the debit side of the forest ledger, however, they often carry such spores into living trees.

When bark beetles approach populations disastrous to the forests, woodpeckers of many species control the insects by chiseling through the thick outer bark for the succulent larvae. The lively tattoo of woodpecker battalions in beetle-infested pine forests is music to the ears of foresters.

A working example of forest sanitation by fungi may be seen in Pacific North-

* Eastern red squirrels often eat the deadly amanitas without being harmed by them. Perhaps other mammals, besides red squirrels, may eat mushrooms that are poisonous to humans, without suffering any harmful effects.—Ed.

west forests which were logged in the wasteful days of "high-stumping." When virgin timber was plentiful and cheap a generation ago, loggers usually felled the trees from "springboards" notched into tree trunks at distances of from 6 to 20 feet above the ground. Not only was it easier to cut trees well above the flaring bases, but also it was less work to saw and chop from springboards than from the brush-infested ground.

These enormous stumps still occupy a large portion of the forest floor in old cuttings, preventing reproduction of trees by natural seeding or by planting. Their removal would entail excessive costs, and stumps of western red cedar and Douglas fir would remain almost intact without the destructive attacks of fungi and their natural allies.

During the long process of disintegration by fungi, each big stump becomes a fascinating community of plant and animal activity. Piles of crumbling wood accumulate around the base, furnishing a home for earthworms and insects. Cavities excavated by woodpeckers in search of grubs become repositories of native hazelnuts gathered by chipmunks and squirrels. When overlooked nuts germinate, the stump becomes festooned with hazel seedlings.

Birds which recently have dined on mountain ash fruits and huckleberries roost on the stump with the eventual result that those two plants usually take over the upper strata. Wind-borne seeds from cedars and hemlocks lodge in the thick mass of fungi and moss which blankets the stump, so that it is not unusual to see trees 20 or 30 feet high growing atop the old forest veteran, their roots creeping down its sides to find lodgment in mineral soil. As the stump crumbles, these tree roots thicken to form a high arched crown above the pile of decaying wood.

Community life on and around the old stump is so complicated and interesting

The aptly-named "shaggy mane" mushroom, *Coprinus comatus*, is good eating if collected before it dissolves into inky fluid.

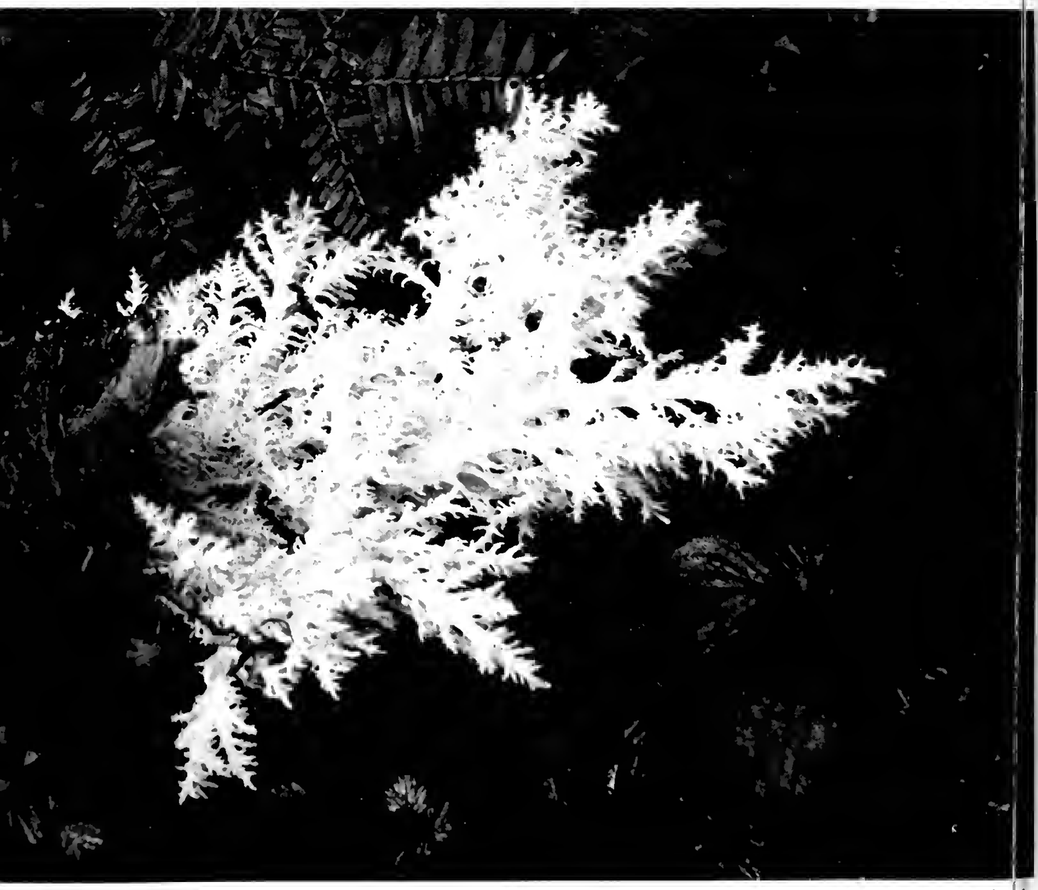
Among the many very handsome mushrooms are some that are poisonous when eaten. This colorful *Amanita pantherina* is especially dangerous.

that it's easy for one to lose sight of the basic business which is being transacted, namely the conversion of hundreds of cubic feet of waste wood into forest mulch. The livelihood of all inhabitants of the stump community depends upon the saprophytic fungi which engineer the initial breakdown of wood structure.

Perhaps the most completely equipped laboratory of "Wood Transformation, Unlimited" is in the unique rain forest of Olympic National Park. Here, for centuries, forest giants have germinated, grown to maturity, died, and plunged to earth, to be dissected and returned to their elements by nature's expert technicians.

One hundred forty-two inches of annual precipitation keep the laboratory humidity at an optimum for fungus growth. Assisting the fungi on disintegrative job in the lab's transition zone—from sea level up to 1,500 feet—are regiments of mosses, lichens and ferns. Out of sight, in secret working cubicles, are armies of busy bacteria and insects, working to build the thick carpet of mulch which protects the life of the only great rain forest within continental United States.

For keeping this and other great forests of our country clean and fertile, fungi and their working associates should be given a medal of honor—with oak leaf cluster—by conservationists and foresters from coast to coast.



The coral-like *Hydnum coralloides* is one of the handsomest fungus growths in the forest.

KEEPING CONIFERS SHAPELY

A little attention at the right time makes all the difference

Frederick Street

Condensed from *Gardeners Chronicle and Gardening Illustrated*

There is nothing worse than a conifer clipped to a Noah's Ark pattern; but sometimes there is a need for discipline. The rigours of the forest—fierce gales, deep frost, heavy snowfall, animal damage—all are generally missing from the average English garden. The wild beauty of the mountains can become blousy in the kindness of a milder climate and the luxury of a richer soil. Conifers can suffer from "spare the knife, spoil the tree." Varieties that are of garden origin, either sports or seedling forms, are as easily led astray as wild species that have been brought into captivity. Some of them have a need for even greater attention if they are to look their best. It is not necessary to watch over them every week but a little work once every two years will make all the difference between a beautiful garden plant and a weed run riot.

The chief complaint from which the conifer suffers is the double leader, the development of two main leading shoots. I am not sure that this is so very bad if it happens early in the tree's life, although it may be more desirable with deciduous trees (for a natural landscape effect) than it is with conifers. But if a spruce, a cypress or a pine develops two leaders when it is already partly grown, then the final result is nothing but unsightly.

Chamaecyparis lawsoniana var. *Wisseli* is a good example to take because it is a garden variety that is prone to this fault. I consider it to be one of the more

The two false leaders indicated by arrows should be removed from this young, 4-foot conifer, *Chamaecyparis lawsoniana* var. *Wisseli.*

A more shapely tree results from removing the false leaders. The central leader is not always the one saved, as seen above.

Young shoots that need to be removed to keep the tree shapely are encircled and indicated by arrows. The shoot at the right is a potential rival to the leader.

interesting and attractive garden forms of *Chamaecyparis*. The foliage is dark blue, the habit is a useful mixture of formality—erect, slender growth—and informality—twisted, inconsequential leaf formation. In addition to this, the plant bears flowers which are large for conifer flowers, giving the blue a flush of red in spring.

But *Chamaecyparis lawsoniana* var. *Wisseli* has two bad habits which need to be checked. It can start to develop two or three leaders when it is adolescent and it can lose the leaves on the lower branches in old age. The remedy for both is simple. For the first, choose the leader that will develop to make a balanced tree and cut off the others with a sharp knife. A clean short cut is best for quick healing and no after effects. The time to do this is after the end of April (to avoid any possibility of frost damage) and before the end of June (to allow plenty of time for new growth).

The top of a young tree only about 4 feet high overall is shown on page 291, bottom left. It can easily be seen that if the three strong branches were allowed to grow the final result would be grotesque The photograph to the right shows th same plant after two of the leaders hav been removed. As will be seen, the cen tral shoot is not always the best one t retain; the conformation of the plant wil indicate the one that is most suitable.

This difficulty could have been over come earlier if the treatment to creat bushy growth had been applied. This i particularly necessary with variety *Wis seli* to prevent it from falling into its sec ond bad habit, the loss of foliage on th lower branches. All that is necessary i to stop the growths, as for chrysanthe mums. It is work that may be done a any time during the growing season. Th method is simple: as soon as a waywar young shoot appears (see photograph a left) it should be nipped off with th fingernails (photograph below).

C. lawsoniana var. *Wisseli* is a particu lar example, one that is almost exagger ated. But this treatment can be applie to any conifer. It could be said that i must be applied to some; *Juniperu squamata* var. *Meyeri*, the blue, spread ing juniper, looks like a bunch of worn out fine brushes without it.

To be honest, I learnt the trick from

Nipping off wayward young shoots is don simply and quickly with the fingernails, a shown above. Other shoots that will b removed are flagged with raffia ties.

nurseryman who grows only about twelve different plants. During many casual conversations I found the secret—as he walked round the nursery during the summer, he pulled off any young shoots that seemed likely to become headstrong. As a result, his plants were always beautifully formed yet without the bristling rigidity that comes from the shears.

Western red-cedar is a valuable timber from Canada. Yet it is not generally known that this is nothing whatever to do with a cedar: it is the wood of a familiar garden plant, *Thuja plicata* (*T. lobbi*). And the timber properties of this tree tie up with its behaviour as a garden plant. Grown in a hard climate the timber is of the finest quality; grown in a mild climate it is useless. Similarly, in the garden *T. plicata* can become lank and unsightly as a young tree (see photograph below).

When this happens sterner treatment is required, almost a major operation. The topheavy mop should be removed at a point where a new strong leader can be selected (indicated by an arrow in photograph below). This new leader should then be trained to a cane, when it will be found that it will take over its duties in

Removal of the top growth and the shoots at points indicated by arrows is necessary to keep this young, 6½-foot tall *Thuja plicata* from becoming lank and unsightly.

After removing the top growth and the shoots, as indicated in photograph below, left, a new leader is trained to a cane. Above is a close-up of the completed operation.

less than a year. The side shoots around and beneath should be cut back, either with the fingernails or with a sharp knife. The photograph above shows the completed job. Provided the work is done before the tree is too large (over 15 feet high) or the sap is flowing too freely, it should not be necessary to cover the wound with grafting wax.

This operation can be used to help solve a problem that often appears impossible of solution. It is sometimes desirable to plant a tree that will be quick growing but which will not become too tall eventually. It is practically impossible to find any variety that will be the perfect answer naturally without the aid of man—it is like expecting a child to reach maturity at the age of ten but never to grow old. By removing the leader and shortening the surrounding growths every three or four years and by pinching back any strong young shoots every year, one can have a tree that will conform to the size that is required but which will not have the cut of topiary or the twist of the Japanese dwarf.

HOW TO MAKE A WEEPING WILLOW STAND UP AND WEEP

Reprinted from *Sunset*, January, 1956

HERE'S the best scheme we know for making a weeping willow tree grow tall—fast. Put in a big stake at planting time. The whole scheme depends on this stake, no matter whether you plant your weeping willow bare root or out of a 5-gallon can. This stake should be about 20 feet long. It could be a 3- by 3-inch post, an unfinished 2 by 2, or a section of ¾-inch pipe, painted an inconspicuous color. Place it about 10 inches from the main stem of the young tree (the trunk will put on considerable girth). Bury or drive it 4 feet into the ground so it will stand strong through the training years.

If wind blows from one direction for very many weeks at a time in your neighborhood, make the stake lean slightly into the wind. For extra safety stretch a guy wire out to brace the tree against the prevailing wind. Anchor the wire 10 to 15 feet from the base of the stake.

Now, examine the droopy branches that grow out from the top of the little tree. Decide which one is the most promising (most erect, longest, thickest, or most foliaged). Pull this branch up and tie it to the stake. But don't try to force it to lie flat along the stake. If you force it too much, it may break at the bending point.

For ties, use strips of old cotton sheeting. Tear pieces about 30 inches long and 12 inches wide and fold them to make strips about 4 inches wide. The ties will look like big bandages for a while, but they will do the job until the trunk begins to expand. While the tree is growing, the sheeting will rot enough to pop open and fall when the trunk fills it to the breaking point. Cloth ties don't cut big creases in the bark, as wire or plastic does.

Pruning and Training

The next step requires some courage on your part. The best way to hasten vertical growth is to cut off *all* the remaining branches. If you cringe from taking such a step, cut out just a few branches, or head back all of them about halfway.

If you cut all but one of the tree's existing growing points (terminal tips), and if the one that remains is on the vertically-trained branch, much of the initial growth spurt will be channeled into that tip and you will get the fast vertical growth and high trunk you desire. This heavy cutting would check or dwarf growth of many slower-growing trees, but the willow is so vigorous that it quickly overcomes any setback.

Two or three times during the first growing season, tie up the newest extension of the selected vertical stem. The trunk may triple its girth the first season and you may have to replace a few popped ties. Side shoots will come out at a rapid rate. Cut them off the lower 6 to 8 feet of the trunk, lest they take over and become big branches placed too low. Above 8 feet let the side branches grow.

When the trained trunk passes the 16 or 18-foot mark (perhaps in the second or third growing season), cut it back a few feet. The side branches will begin to grow as strong primary branches. At that point you have the beginning of a full-blown, high-crowned weeping willow. When the trunk becomes large enough

If a weeping willow is left completely alone it may be disappointing, taking on its weeping form when only 6 to 10 feet high . . . giving no shade to sit under, and having no grandeur for a number of years.

to stand alone, remove the stake.

If you have an untrained willow that has been in the ground for several years and is branching too low, you can use this same plan to make it grow and branch higher. The branch you choose to train up along the stake may be too thick to pull up straight. You may have to leave a kink or bend where you pull it up. But, in the long run, this won't hurt the tree's appearance, for the bend will eventually become a graceful curve.

The culture that makes a willow grow fast and luxuriant is simple: just water and feed it as often as you possibly can. Never worry about supplying too much of either—especially water. If you cover the root area with a 4-inch layer of shavings, sawdust, gravel, sand, or similar material, you can water and feed your willow as much as you wish without discomforting nearby plants, as you might if it were in a lawn or garden bed.

You can contain the vigorous root system of a willow fairly well within an area of 500 to 1,000 square feet if you cover the area with a water-retentive mulch and keep it moist all the time. Feed the willow by scattering complete commercial fertilizer over the entire mulched surface—a lawn spreader is good for this job.

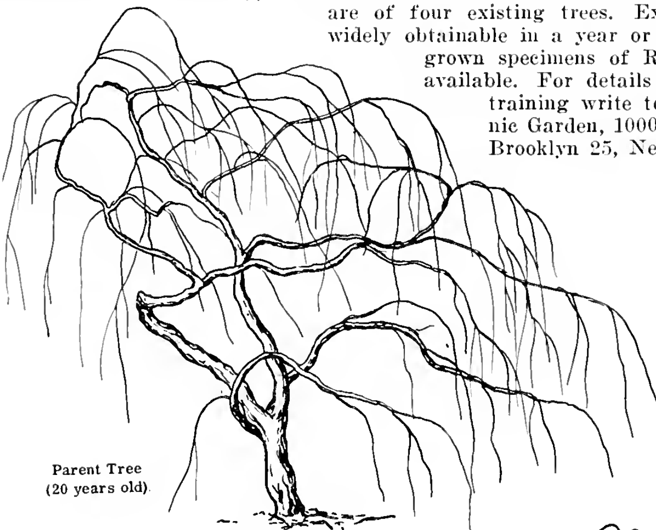
Drawings courtesy Sunset

By making a vertical leader or trunk from a stout side branch . . . and cutting off low branches as the tied leader goes up the stake . . . a green canopy and cool, light shade will be produced in a few years.

RED JADE

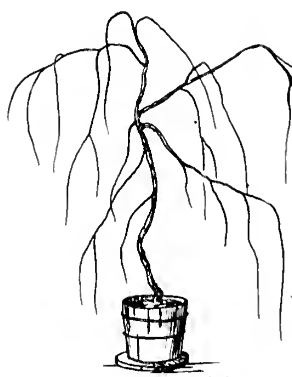
A training tip for owners

The beautiful weeping crabapple RED JADE, developed at the Brooklyn Botanic Garden (Plant Patent Number 1497), lends itself well to training. The drawings shown here are of four existing trees. Expected to be rather widely obtainable in a year or two, a few specially grown specimens of RED JADE are already available. For details and instructions for training write to the Brooklyn Bota nic Garden, 1000 Washington Avenue, Brooklyn 25, New York.

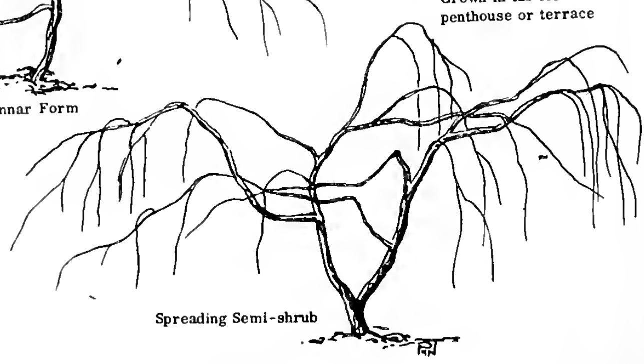


Parent Tree
(20 years old)

Columnar Form



Grown in tub for
penthouse or terrace



Spreading Semi-shrub

SEASIDE PLANTS DEFY THE ELEMENTS

Cape Cod gardeners discover the plants that can survive the rigors of a seaside climate

Copley Amory, Jr.

Condensed from *Horticulture*, February, 1956

THE term "seashore exposure" is relative. Half a mile from the shore, a different set of conditions pertain than by the sea. In our case we are on an island and have full exposure, moderated only by windbreaks of trees, a few stone walls and slopes in the terrain.

Not adjacent to Atlantic billows, our planting area is bounded on the north and west by a shore that receives winds directly off Buzzards Bay and on the south, the winds off Vineyard Sound. Much of our area might as well be on the water so far as the strength and the salt component of the winds are concerned.

Our terrain has the shape of a shallow bowl. Its east-west elongated bottom is a swampy area, protected partially by parallel ridges rising on each side. The prevailing fair weather winds from the west—hot in summer, cold in winter—do far more harm than the sporadic storm winds from the east.

Under these conditions, the choice of plants is obviously limited. More than ever do we find the old adage applicable that it's better to put a one-dollar plant in a 10-dollar hole than vice versa. We have a milder climate than the Boston area, but many plants which prosper there will not survive our conditions.

We have been at it seven years. Lord Aberconway, that patriarch of English horticulturists, used to say it took fifty years to make a garden, and he would certainly have increased the time had he considered hurricanes. In every sense we are pioneers.

Evergreens

For our particular situation, we give top priority to American holly (*Ilex opaca*) and Japanese black pine (*Pinus thunbergi*). Whether exposed or sheltered, on a high and dry or a low, moist spot, *Ilex opaca* seems to do equally well. It is superb if given plenty of oak leaf-mold and an occasional dose of cottonseed meal. Japanese black pine thrives on sand, salt and wind.

Other evergreens high up on the list are keteleer cedar (*Juniperus chinensis keteleeri*), Black Hills and Colorado spruces, Veitch and Nikko firs, as well as mugho, Montana, China, Austrian and Tanyosho pines. The Sargent juniper grows like a weed, as does the Pfitzer.

Hollies (*Ilex opaca, I. aquifolium* and *I. aquipernyi*), and Black Hills and Moerheim spruces all had their roots under salt water in the 1954 hurricanes. The hollies were submerged for several days. Yet none suffered except one holly, the inkberry (*I. glabra*), which died.

We recommend the keteleer cedar to all who seek an effective windbreak near the seashore. While all our fifty-odd swamp cedars (*Chamaecyparis thyoides*) suc-

Gottscho-Schleisner

Situations near the sea are a challenge to plants. Among those that meet it best are the native conifers, pitch pine (*Pinus rigida*), and juniper (*Juniperus virginia*) shown above.

cumbed completely, and the red cedars (*Juniperus virginiana*) were badly burned, the keteleers took the hurricane completely in their stride. They are attractive trees as well, and do not seem to suffer from cedar rust.

Of evergreens which we have tried and would place in a *neutral* or *negative* category are tiger-tail, Serbian, dragon, oriental and Himalayan spruces, white, red and lace-bark pines and white firs.

One feels that tiger-tail spruce ought to be rugged enough to take anything, but after a few years' trial this plant (which should be called "porcupine" spruce) gradually but steadily dropped from the ranks. The beautiful pendant-branched Serbian spruce shows somewhat more resistance, but it has been subject to fungus and die-back.

The dragon spruce, notwithstanding its reputation for seaside planting, has been

a major disappointment. It starts out with a flurry of energy and cooperation, but as time goes on, first one lower branch dies, then another, until half the tree is denuded. Yet the other half continues to burgeon with new growth in the spring.

Oriental spruce, we soon decided, was not for us, and we moved those we could to sheltered positions where they are developing into attractive broad bushes. One which was left on our exposed ridge we gave up for lost. This last year, to our amazement, it has come to life. The only apparent explanation is the increase in the size of its sheltering neighbors.

We have a little Himalayan spruce (*Picea smithiana*) which for several years has been painfully trying to keep alive. Now, like the oriental spruce, it seems to have become established.

The lovely white fir, which is supposed to like the seashore, has made valiant efforts on our exposed ridge, but its growth is retarded by the wind and its foliage suffered from last summer's hurricane.

Needless to say, our 3-foot giant sequoia, which was submerged in salt water last summer, was promptly killed, as was our 10-foot metasequoia, which was on higher ground and had prospered well for several years but could not take the hurricane wind.

Cryptomeria remains an enigma. Notwithstanding dire prophecies from several experts that it was too tender for us, it has done surprisingly well except for the hurricane. A cryptomeria flourished for many years on windswept Cuttyhunk Island, which is almost devoid of trees. One planted 30 years ago still survives on a bluff facing three-quarters of the compass at Monument Beach, suggesting that this tree is at home with normal winds and salt.

However, the hurricane last summer burned many of our plants badly. These were pruned, but the die-back progressed actively during the winter and some have even died. Twelve 2- to 3-foot plants grew successfully for years on a slope, but were inundated by the tidal wave last summer. Three were completely unaffected, three were wounded and are recovering, and six died at once. Of those completely unaffected, two were in the bottom row and subject to the maximum degree of inundation.

Deciduous Trees

Among deciduous plants, our indigenous trees—beech, black and white oaks, swamp and sycamore maples, tupelo, and honey locust—behaved in the hurricane as expected. They killed back according to the degree of their exposure and submergence.

A tree which has surprised us for its endurance of seaside conditions is the white ash (*Fraxinus americana*). The English elm (*Ulmus procera*) has also proved as hardy as any and hardier than most. Though the Russian olive (*Elaeagnus angustifolia*) has belied its reputation for hardiness, the autumn and cherry elaeagnus (*E. umbellata* and *E. longipes*) have proved extraordinarily resistant, flourishing like the proverbial bay tree under normal conditions and surviving hurricane wind and immersion in salt water.

Our golden larches (*Pseudolarix amabilis*) are tiny plants and grow very slowly. Our weeping larch (*Larix decidua pendula*) prospered until the hurricane, as did our small Kurile larch (*Larix gmelini*), which grows in the Orient where conditions are similar to ours. The Siberian pea-tree (*Caragana arborescens*) thrives on our ridge, and its variety, *lorbergi*, is also hardy, with a feathery, graceful form.

Fruit and Nut Trees

Various nut trees do well. An unusual and ornamental variety is the cut-leaf walnut (*Juglans nigra laciniata*). Until the hurricane the foliage of our two Chinese persimmons (*Diospyros kaki*) had an autumn color of deep scarlet that was richer than that of oak or maple. Our two common persimmons (*Diospyros virginiana*) were bathed four feet in salt water in 1954, but still show considerable life.

Photographs courtesy of Y. Hagihara

The Acclimatization Garden is located on a hill; beyond can be seen Japan's Inland Sea.

A UNIQUE PRIVATE GARDEN IN JAPAN

In an unusual garden plants are tested by a dedicated Japanese horticulturist for use in his country

Courtesy of the *Sun Pictorial Daily*, Tokyo, Japan

On Shodo Island in Japan's Inland Sea, Mr. Kanichiro Yashiroda has established his Plant Acclimatization Garden. Here for some 30 years he has been introducing sub-tropical and temperate-climate plants, devoting his time and most of his resources to the work.

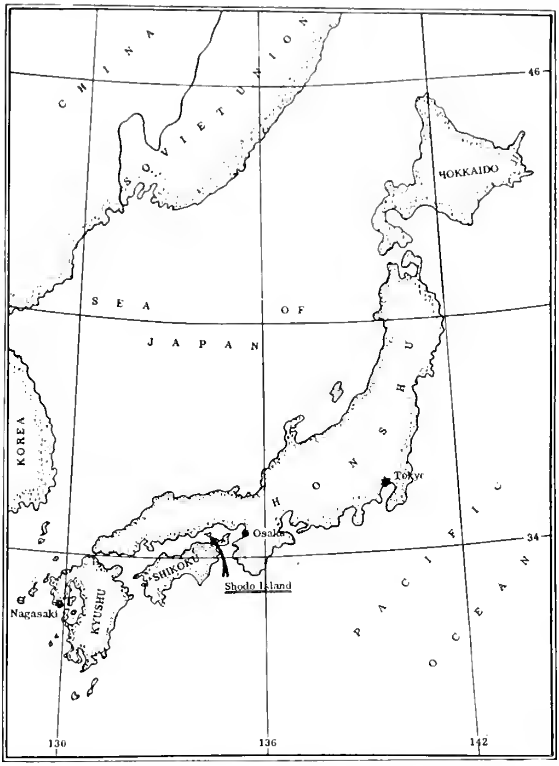
The climate of Shodo Island is mild and the luxuriant growth of sub-tropical and desert plants gives parts of the garden the appearance of a miniature jungle. In early winter both Sasanqua and Japanese camellias bloom together with polyanthus narcissus and winter-flowering Japanese cherries, while the persimmon trees are laden with delicious scarlet fruit.

Before establishing his garden, Mr. Yashiroda studied at the Higher Horticultural School in Akashi near Kobe, Japan, and at the famous Kew Gardens in England. Readers of PLANTS & GARDENS know him as the guest editor of the popular *Handbook on Bonsai,* and many had the pleasure of attending his courses on bonsai held at the Botanic Garden during his stay here in 1955.

Kanichiro Yashiroda among some of his many palm trees.

Younger son Toshiki and his father look over the collection of desert plants.

Washington palms (*Washingtonia filifera*) over 40 feet tall were grown from seed planted about 30 years ago, when the Acclimatization Garden was begun.



Map of Japan showing Shodo Island (see arrow). It is about as far south as Atlanta, Georgia, and enjoys a mild climate.

Toshiki and his sister, Mie, examine some of their father's miniature bonsai.

Photograph courtesy of K. Yashiroda

Photographs courtesy of author

Small plants were found growing even on the bare surface of McGarry's Rock, only about seven hundred miles from the Pole.

FLOWERS IN THE ARCTIC

During the short summer of northern Greenland tiny blossoms emerge from crevices in bare rock. Some of these plants may have survived from a time when hardwood forests covered the region.

Rutherford Platt

Condensed from *Scientific American*, February, 1956

HALFWAY up the coast of Labrador a red spruce stands as the last outpost of the tree line. Beyond it stretches a frozen wilderness where plant life soon seems to peter out altogether. Flying northward in an airplane, you see occasional green patches where crowberry grows in the tundra. If your course takes you over the south shore of Disko Island, just west of the middle part of Greenland, you may be lucky enough to see, nestling in a mountain sunbowl, a lush green meadow of flowers. But this solitary freak of nature—a natural botanical garden 150 miles north of the Arctic Circle—looks like the last bright burst of an expiring world. Northward, where the tundra ends, all signs of vegetation disappear,

and there is only a sterile white world of ice and lifeless rock.

That plants may actually survive and flower in this frozen world seems inconceivable. And yet they are there for the finding. Tucked away among the rocks is an astonishing wealth of tiny wildflowers. Inured to the cold, dwelling in an environment where insects and diseases are unknown, they are the healthiest and most vigorous of all the world's flowers.

In 1947 and again in 1954 I had the happy opportunity to hunt these flowers as botanist with expeditions led by Commander Donald B. MacMillan. Both times we sailed in his schooner northward between Greenland and North America as far as Kane Basin, at the edge of the Arctic Ocean. (See map on page 309.) We explored more than 1,000 square miles of fiord, island and icy coast, and from the 1947 trip alone we brought back some 3,000 specimens of arctic flowers.

They were often as difficult to discover and pluck as the fabled edelweiss. With the schooner's bow thrust against a cliff, we would leap from the bowsprit to a narrow ledge to find a bluebell or a knotweed. We would land in a dinghy on a finger of the Greenland Ice Cap, scramble

The expedition ship Bowdoin moored to the rocks at Etah.

Arctic primrose (*Primula farinosa*) was found on Disko Island.

over the solid ice, and discover on the other side a sunpocket where fireweed and poppies grew in the shelter of huge rocks. Tiptoeing the ship in among offshore pinnacles of rock, we would climb a pinnacle and find in its crevices clumps of grass (*Poa* sp.) or chickweed, where birds made their nests.

It was on McGarry's Rock in Kane Basin, the northernmost point of our voyage, that we made the most surprising finds. This small island faces the great polar ice pack. Its north slope was being ground under the pressure of millions of tons of ice. A strong, bitterly cold wind pours down from the Pole, and the winter temperature falls to 75° F. below zero. Yet even there we found a few lichens living in the cracks. Judging by what we found on McGarry's Rock, I believe that seed plants would grow at the North Pole itself if there were any rock. On the south slope of the island we discovered pockets of saxifrage, flowering chickweed and grass with stems four inches long—giant plants for this part of the world.

How do these living things manage to survive? They are beaten ceaselessly by winds and swept by snows almost as dry as dust. They get only a scant eight weeks of sunshine and must wait out

Mouse-eared chickweed (*Cerastium alpinum*) is common in the North.

Eyebright (*Euphrasia arctica*) is a rare polar annual.

forty-four weeks of polar night. The polar air and the rocks are as arid as the desert. There are no springs, no swamps or bogs, few level places. There is no soil, and often not even a trace of sand, in which plants might gain a foothold.

Although the sunshine lasts only eight weeks, the plants can grow rapidly because they have it twenty-four hours a day. Their water supply comes from the ice. From the melting glaciers in summer, water runs into crevices in the rock, where it dissolves minerals. For soil and a sheltering winter mulch the plants use dead leaves, which accumulate year by year. Most of them grow cactus-like leaves—leathery outside and filled with water inside. Among the hairy-coated ones are the mouse-eared chickweed, lousewort, grasses and the tiny polar buttercup (which is only one inch tall). All the plants are low-growing, usually less than ankle high. The showy blossoms of the fireweed (*Epilobium*) and the arctic rose (*Dryas*) seem to bloom directly from the rock.

Hardiest of all the seed-bearing types are the mouse-eared chickweed (*Cerastium alpinum*), the red bulbil saxifrage (*Saxifraga cernua*) and the grass known as alpine foxtail (*Alopecurus alpinus*). These three musketeers belong to fami-

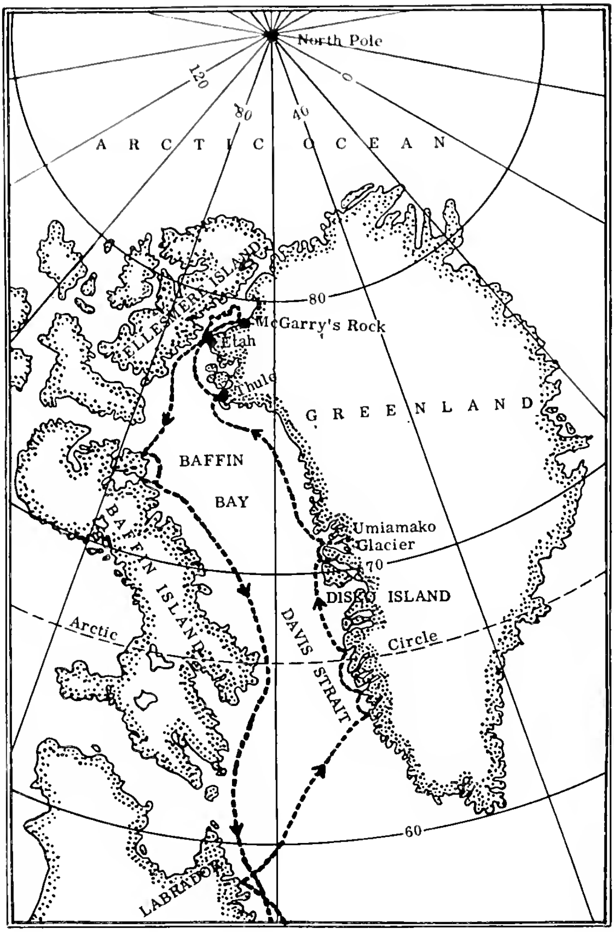
The blossom of *Pedicularis lapponica* resembles a small orchid.

Golden saxifrage (*Chrysosplenium tetrandum*) has no petals.

This saxifrage, like desert cacti, is well adapted to dry climatic conditions.

Northernmost trees seen by the 1954 expedition were in Labrador, 2200 miles south of the North Pole. In Scandinavia, warmed by the Gulf Stream, trees grow much nearer the Pole.

The eider ducks build nests of warm soft down on the frigid rocks. Each nest is surrounded by a circle of grass fertilized by droppings deposited in a ring by the ducks.



Map shows track of 1954 expedition. McGarry's Rock is on the east shore of Kane Basin, which lies between Greenland and Ellesmere Island about seven hundred miles south of the Pole. Refuge Harbor, not marked on map, is on the coast of Greenland, just east of McGarry's Rock.

lies notable for their hardiness. But to live on bitter McGarry's Rock they need more than hardiness. In the few short weeks of summer sun, they cannot go through the full cycle of sprouting, flowering, ripening fruit and seed, and planting the seed. So these three species short-cut the long process of reproduction by seed.

The red bulbil saxifrage bears no flowers at all. Clusters of tiny bulbs, which look like shiny red tops, form directly on its stem. These break off easily, roll a few inches away and can produce new plants vegetatively. The grass has adopted the same device. In place of stamens, pistils and seeds it has scimitar-shaped bulbils which dive to the earth when caught by the wind, like a kite without a tail, so that they fall close to the parent clump. Chickweed apparently does not reach the seed-producing stage, and it, too, must reproduce vegetatively—by spreading its roots.

For all their hardiness and special adaptations, our three musketeers still could not survive on McGarry's Rock without an equally hardy animal—the eider duck. The duck nests on the coldest rocks and ledges. It deposits fertilizer on the rock in a circle of precisely the right diameter for its nest; there a

Tiny flowers were discovered on this 4,500-foot cliff near Umiamako Glacier on the west coast of Greenland.

corresponding circle of grass takes root and flourishes in the cuddling shelter of the nest. We found scores of these nests, each with a perfect circle of fertilizer and grass around the down, on McGarry's Rock.

The three musketeers on McGarry's Rock are exhibits of how plant life can adapt itself to face incredibly hostile conditions by taking advantage of every little local opportunity. But the richest polar oasis we discovered was at Refuge Harbor, on the Greenland coast east of McGarry's.

Here near the northern tip of Greenland we found two major botanical surprises. The moment we landed on the rocks at the water's edge we encountered species of plants which, so far as I know, had never before been seen growing anywhere except high on mountains. At this far northern latitude these "alpine" species—the opposite-leaf saxifrage (*Saxifraga oppositifolia*) and a poppy (*Papaver radicatum*)—had come down to sea level and were growing literally on the beach at the water's edge.

The other surprise was a vigorous colony of *Saxifraga flagellaris* that was unlisted in the standard manuals of northern flowers. The quintessence of the surprise came a year later when the famous English mountaineer, Francis Smythe, in his book *The Valley of Flowers* reported finding the same species at the snow line high in the Himalaya Mountains!

A century ago the eminent botanist Asa Gray, pointed out the astonishing

parallels between plant genera and species in northeastern Asia and in northeastern United States. In our own day A. C. Seward and others have advanced the theory that during the Upper Cretaceous Age an arctic forest circled the earth around the Pole, and that when the Ice Age sheets spread southward later, arctic plants moved down into the eastern United States and Europe. So plants evolved in the Himalayas may well have traveled around the earth by way of the Arctic and come to North America over a land bridge at Bering Strait—or vice versa.

On the western coast of Greenland about 300 miles north of the Arctic Circle, the geologist of our expedition, William E. Powers, spotted an exposure of Upper Cretaceous sandstone. We attacked the shale with crowbars and mallets, and unearthed many fossil remains of the arctic hardwood forest of seventy-five million years ago. My notes, made on the spot, say: "Here were the outlines of leaves, twigs, wood . . . what seemed to be the tip and lobes of sassafras . . . I thought I found the perfect imprint of sycamore—another, part of a large fig leaf. Most common were the imprints of elm seeds." They were easy to identify, with their circular wings like hat rims. I shall always believe that our crowbar dislodged a piece of shale recording where, in a climate like that of present-day New England, rain water had washed elm seeds together millions of years ago just as rain washes them together in the gutters of our elm-lined streets today.

We piled up our treasure of fossils in the ravine where we had dug them out and returned to the schooner for a cup of coffee and more help. But within the hour a strong wind sprang up, a snow squall struck the ship and moving icebergs literally pushed the schooner out of the cove. We could not regain the shore. On our second expedition seven years later some of us went back to pick up the pile of fossils, but our ravine was beyond reach: prodigious icebergs made a landing on the shore impossible.

Lychnis alpina is an abundant arctic flower, many of whose southern relatives are common weeds.

Phyllodoce coerulea is a member of the heath family, as are rhododendrons, azaleas, and blueberries.

GARDENS HELP ME GROW

Grace V. Sharritt

Condensed from *Popular Gardening,* August, 1956

NOT long ago my young friend Lucy said, "This will be our third move in seven years. Just as I get a peony to bloom, or a shrub through the spindly stage—wham! we move and I have it to do all over again. But it's the last time. I am through planting gardens for other renters."

I knew what she meant. I also have moved around the country. I too have pulled weeds and planted seeds in half a dozen states. Many a time, like Lucy, I have vowed, "Never again."

But inevitably there would come a morning—one of those dew-pearled mornings spangled with bird song—when I would wander through dandelions, or tin cans or rocks, and all my firm resolutions would vanish into a packet of flower seeds and a sack of fertilizer.

I told Lucy about my yard in a Wisconsin logging town. It was a dump heap. I cleaned it and almost gave up in despair when the grass seed did not germinate. But after two summers there was green where there had been clay and birds in the wild grape I had coaxed into covering an old arbor. And I learned that plants, like people, respond to love, patience and care.

It was awfully hard to leave that place for a prefab cottage in a bustling subdivision in Ohio. Again no grass. No vines. No trees. Just mud, packed hard as cement.

A few kind neighbors helped me with that yard. They gave me hollyhock seedlings, iris roots, and clumps of daisies and sweet William. The little yard came to life and grew. I grew too that summer. I learned that you are never alone when you are gardening.

The back yard in an old residential Detroit neighborhood was another matter. That is when I stormed, "Never again! Let someone else clean the trash. I'm through."

I meant it. Or thought I did. But along came one of those dewy mornings. A robin sang his head off on the broken-down fence. Before I knew it, my gardening jeans were on and I was raking the trash away.

It took four summers to convert that yard into a miniature city garden. Pink ramblers climbed over the new fence. A trellis of sweetpeas perfumed the back porch. Willow shrubs hid the unsightly alley fence. More important, though, was the interest displayed by other renters on the block.

Lots of them never had bothered to plant a single flower. They came over and asked questions. Now it was *my* turn to help someone make a garden. Now *I* could divide clumps of iris to give away. Now people came to *me* to find out how to transform ugliness into beauty. In one summer our city block was flowering proof that even transients can make a community a better place to live in.

Then came the move that meant no garden, no yard, just an apartment windowsill. What a test that was! How I longed for the gardens of past years. How I ached for the grape arbor, the pink ramblers, the feel of cool, soft grass under my feet.

But I was lucky at that. My second-story windowsill opened on a tiny open balcony. The sun and stars looked down on the long box I filled with petunias, vineas, begonias. So did the rain, watering and freshening the flowers, washing away the factory soot.

Then I learned something about economizing with plants, reducing gardening to a minimum. I learned to experiment with indoor plants, with all kinds of seeds and bulbs. My hoe was a kitchen fork, my spade a mixing spoon. Instead of hauling a wheelbarrow full of fertilizer around a big back yard, I put a tablet into sparkling tepid water and gave the solution to African violets, begonias, ivy. I learned here to be resourceful, to do the best I could with what I had.

After nine years of gardening in a small apartment, imagine the time I had adjusting to my next garden—a 25,000-acre ranch. I floundered like a minnow in an ocean. All I could see were rocks, sagebrush, semi-desert land.

"I can't do it," I would say, rubbing liniment on sore muscles. "It's more than a woman can bear."

Well, it is surprising what a city-bred woman can do and what she can bear if she loves a garden. In high-altitude gardening zinnias do not have a chance to bloom, snap beans to mature in the too-brief summers. And nothing looks sillier, in a land noted for ruggedness and survival of the fittest, than a dianthus drooping its frosted pink bud in July.

Though the dianthus did not, I survived and waxed hale and hearty. I survived and learned to adjust my life to bigger things and limitless horizons. I also learned (once I understood what was what) that even in a country seemingly unfriendly to soft beauty, cultivated flowers, and dudes, I could grow wonderful things by using patience, foresight and tolerance.

Today people hungry for color visit the garden I hacked out of a clearing.

"Such beautiful delphiniums!" they say. "I never knew columbines would grow in a garden," they murmur. "Of course wild ones do in the canyons but these are different."

"I am trying to cross-pollinate them," I say. Because, you know, a gardener goes on, never stops learning. Breeding new plants is a tremendous challenge.

Last week I had a note from Lucy, in Denver. She wrote, "It's not much of a place here. And you can't imagine what I am up to."

I could but I went on reading. "I've some of that new stuff that helps break up hard clay. I planted a rose bush yesterday. I've met the nicest woman (next door) who is going to give me some asters and stock. I . . ."

I smiled. Time rushed back. I was in that Wisconsin logging town, the Ohio subdivision, the Detroit back yard, the city window garden.

Lucy, bless her, was all right. She has "a garden in her face where roses and lilies show . . ." She has a gentle heart, a strong back, love for the earth and her fellow man, and imagination to make the best of what life offers.

McFarland

PASTE THE POISON-IVY

Painting poison-ivy stems with a mixture of 2,4-D and 2,4,5-T in a greasy carrier kills this pest without damaging desirable plants nearby

Karl Sax

Condensed from *Arnoldia,* April 13, 1956

THE eradication of poison-ivy is not an easy task under the most favorable conditions, but it is even more difficult when the ivy is growing among ornamental vines or ground-cover plants, in hedges, or climbing up small trees and shrubs. Under these conditions the ivy cannot be sprayed with weed killers without killing the ornamental plants. For most people the destruction of poison-ivy by pulling it out of the ground is a hazardous operation. It is also difficult to pull out all of the roots, especially if they are interlaced with the roots of adjacent ornamental vines and shrubs; and the remaining roots will often send up new shoots.

Poison-ivy can be killed with the non-selective herbicides, such as ammonium sulfamate, or with 2,4-D and 2,4,5-T which do not kill the grass. The ivy can be sprayed with any of these weed killers, but all or most of the nearby plants will also be killed. The non-selective weed killers can be painted on the stems and on larger vines or the dry crystals can be put in frills cut in the base of the trunk, but there is still some danger of killing adjacent plants. The fumes from 2,4-D are even more hazardous to neighboring ornamental and crop plants.

About five years ago my wife, who is on the grounds committee of the Friends of the Peter Bent Brigham Hospital, asked me how she could get rid of a large poison-ivy vine growing on the wall of one of the buildings, which was covered with Boston-ivy. The poison-ivy plant could not be sprayed without killing the Boston-ivy, and it was too large to be

Poison-ivy on this maple was killed when its stems were smeared with weed killer paste. However, neither the euonymus ground cover nearby nor the maple were injured.
Courtesy of Arnold Arboretum

pulled out by the roots. We needed a weed killer which would be effective when applied to the stem of the vine, but one which would not injure the adjacent ornamental vines.

We first tried a mixture of 2,4-D in a lanolin emulsion. The material was tested for fume drift by painting the greasy mixture on a pole stuck in the ground and placing a young potted tomato plant within a foot of the pole for a day. The tomato plant was uninjured, although extremely sensitive to 2,4-D fumes.

We then felt that it was safe to try the weed killer emulsion on the poison-ivy vine at the hospital. The base of the stem was nearly 2 inches in diameter, and the bark was thick. In order to permit the weed killer to enter the stem more readily, a thin strip of bark was cut from one side of the base of the stem for a distance of about 1 foot. The emulsion was then brushed on the cut stem. Within several weeks the poison-ivy was dead, the Boston-ivy uninjured.

The emulsion weed killer was later modified, using a commercial weed killer containing equal parts of 2,4-D and 2,4,5-T. One part of the concentrated (35% 2,4-D; 33% 2,4,5-T) brush killer was mixed with nine parts of a greasy carrier. In addition to lanolin we have used waxes, heavy lubricating grease and even vegetable fats, such as Crisco. Any carrier is satisfactory if it mixes well with the brush killer, is viscous enough to stick on the stem in hot weather, and thin enough so that it can be painted on the stem with a small brush.

If the poison-ivy stems are small, the emulsion can be painted directly on the bark, but if the stem is thicker than about a third of an inch, a thin strip of bark should be removed along one side of the stem, or longitudinal slits made in the bark, to permit the weed killer to enter the stem. The weed killer must enter the bark and be carried down to the roots to be effective. It can also be absorbed by the leaves, but it is a tedious job to smear the leaves with the greasy mixture. The weed killer is most effective if applied early in the summer, when the vines are growing vigorously, but it is effective at any time during the growing season.

We have used this weed killer on poison-ivy vines growing up young pine trees, along stone walls and among ornamental shrubs. It can also be used to kill almost any weed tree or vine. During the past summer we tried it on a heterogeneous lot of young trees, shrubs and vines which were growing in a hedge of *Rosa virginiana* in the Arnold Arboretum. In this rose hedge, which is nearly 400 feet long, were more than 100 seedlings of weed plants ranging in size from 4 to 6 feet tall. Among them were 11 apples, 21 cherries, 17 barberries, 16 bittersweets, 15 grapes, 22 maples, 20 oaks and 6 black swallow-worts. The test was made by two of our summer helpers, Edward Dowgialo and Robert Newman of the Jamaica Plain Agricultural High School. The weed killer was applied in mid-July. By the middle of August most of the weed trees were dead, with no injury whatever to the rose bushes. A few maples have survived, but they may have been missed in the treatment. Unfortunately one of our worst weeds, the black swallow-wort (*Cynanchum nigrum*), was not killed or injured, even though the slender stem was split lengthwise and the emulsion was forced into the slits.

This type of brush killer can easily be prepared, or may now be bought from dealers in horticultural supplies. If large quantities are needed it can be made more cheaply by buying the necessary ingredients and mixing them at home. The commercial preparation is packed in a small jar, complete with a small brush and two long plastic bags to cover the hands and arms, preventing contact with the leaves and stems of the poison-ivy plants. It would also be advisable to slip a transparent plastic bag over the head to protect the face. If the plastic bags are to be used again they should be washed thoroughly.

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CHANGING CONCEPTS IN THE FIELD OF FOLIAGE FEEDING

P. P. Pirone

Condensed from *Flower Grower*, July, 1956

THE value of supplying nutrients to plants by means of leaf sprays remains a controversial subject. Some agronomists still question the value of the practice. Others, including horticultural scientists, know from actual experience that many kinds of plants can be helped a great deal by application of nutrient sprays to the leaves. More vigorous plants and greater yields of flowers and fruits frequently result from additional feeding with such nutrient sprays.

Recent research at Michigan State University has done much to change some of our older ideas.

Radioactive isotopes have made possible our new understanding as to which elements leaves can absorb from nutrient sprays, how the nutrients move once they are inside the leaves, and how they are utilized. Plant foods containing nitrogen, potassium, calcium, phosphorous and other nutrients can be made radioactive and are thus tagged. When such materials are sprayed on the leaves, the radioactive particles are absorbed, distributed and utilized by the plant in the same manner as are the normal ingredients. Because the radioactive materials can be detected later by radiation counting, with X-ray film or other special apparatus, the exact amount of the nutrient absorbed or utilized can be measured. Thus with the aid of this technique scientists have been able to delve more deeply into the mysteries of what takes place inside plants.

Leaves of many kinds of plants are capable of absorbing far more material than formerly believed possible. One reason is that relatively large areas of absorbing surface are involved. The leaves of a twelve-year-old apple tree for example, have an area equal to one tenth of an acre, or approximately ten times the spread of the tree.

An even more important reason, however, is the newly discovered fact that leaves are better equipped to absorb nutrients than we had formerly realized. I was taught that all leaves are covered with a continuous, impervious, waxy material called cutin, and that the only natural openings in leaves were the breathing pores (known as stomata) and water pores (hydathodes). It was believed that the only way liquids or gases could enter a leaf was through the natural openings, particularly the stomata.

Recent research has revealed, however, that instead of a continuous coating of cutin over the surface, leaves also have pectin-like substances interspersed with the cutin in the outer walls of the surface cells. The pectin-like substances have a great capacity for absorbing and releasing water and nutrients. They provide a direct connection between the outside atmosphere and the interior of the leaf and the entire plant.

The pectinaceous substances are present on both the upper and lower surfaces. Not long ago we believed that the lower leaf surface was the more important portal of entry because of the greater number of stomata on that surface. This

apparently is not so. The upper surface of a bean leaf can absorb as much phosphate as the lower surface can, even though it has only one-seventh as many stomata.

Applying Nutrient Sprays

I once believed that the best time to apply nutrient sprays was between ten in the morning and two in the afternoon, the period when stomata are most likely to be open. Now we are told that the amount of nutrients absorbed by the leaves is not dependent on open stomata. Tobacco leaves absorb from three to ten times as much tagged nitrogen in urea at night as they do during the daytime. It appears that the higher humidity at night is one important factor which governs the rate of nutrient absorption.

Even the leaf stems, called petioles, are efficient absorbers of plant nutrients.

Here are some additional observations and conclusions based largely on the Michigan State University research. The kind of chemical used in foliage sprays has a marked effect on the absorption rate. For example, phosphorus in the form of orthophosphoric acid is absorbed in greater amounts than phosphorus in the form of ammonium, potassium or sodium phosphate. From two to ten times more phosphorus is absorbed by plants from the acid than from the phosphate form.

Young, rapidly expanding leaves absorb more nutrients, per unit area, than do fully mature ones. Generally speaking the more vigorous the plant, the more nutrients it can absorb via the leaves.

Not all plants have the same capacity for absorbing nutrients via foliage sprays. A bean leaf can absorb more than a tomato leaf, and apple leaves are more absorptive than are those of peach.

Nitrogen applied in the form of urea is the most readily absorbed of the major elements. In fact, the entire nitrogen requirement of some crops can be satisfied by means of foliar sprays.

After the urea in solution is absorbed into the leaf, it is split up into ammonia and carbon dioxide by the enzyme urease.

The more responsive a plant is to urea sprays, the weaker must be the solution applied in order to avoid "burning."

Cucumber and bean, the most responsive to foliage sprays containing urea, can tolerate a spray containing a pound of urea in 25 gallons of water. Apple, corn, grape, tomato and strawberry are slightly less responsive and can safely be sprayed with a pound of urea in 20 gallons of water. Celery, cherry, peach and potato, the least responsive, can tolerate a pound of urea in as little as 5 gallons of water.

The rate of movement of nutrients such as nitrogen, phosphorus and potassium absorbed via the leaves has been estimated at an inch in five minutes.

Unlike nitrogen, phosphorus and potassium, calcium does not move downward from the leaves. Despite this fact, however, calcium and its close relative, magnesium, are absorbed by leaves and thus can be applied to the leaves of plants such as celery to overcome a deficiency of those elements.

That nutrients could move out of the leaves, as well as in, was shown. Such nutrients may be leached out of leaves during rains or when constant mist is applied.

Bark Also Absorbs Nutrients

One of the most unusual discoveries made by the Michigan scientists was that the bark of trees can also absorb nutrients. They wrapped cotton gauze which had been impregnated with radioactive phosphorus and potash around the branches of apple and peach trees, and were able to detect the radioactive materials inside the branches 18 to 24 inches above and below the point of application within twenty-four hours. This absorption could occur even during the winter when the temperatures were below freezing.

They also found that most absorption by the bark occurs when the nutrients were applied just before the buds begin to swell in early spring. The nutrient

solution applied to the bark can be ten times as strong as that applied to the leaves, without causing damage.

This method makes it possible to supply important nutrients, before the start of the growing season, to trees that have suffered some winter injury or that may have a nutrient deficiency.

A fitting way to conclude this brief discussion on foliar feeding is to quote part of the report made by Dr. Wittwer and his colleagues to the Atomic Energy Commission:

"The greatest value of nutritional spraying will likely be realized on crops where certain deficiency disorders can be easily corrected by spray treatments, where spraying is already an established practice, where total leaf areas are large, where conditions are not optimum for nutrient uptake by roots, and when there is a great demand for nutrients such as during flowering and early fruit set. These values are associated with leaf-feeding not as a replacement of soil fertilization but with its supplemental or booster effects. With few exceptions, it is feasible even with several applications to supply only a part, often a small part, of the total nutrient needs in crop production by nutritional sprays. The remainder must be absorbed by the roots."

RID THE GARDEN OF MOLES AND RABBITS

Alfred Putz

Reprinted from *The New York Herald Tribune*, May 27, 1956

A SERIOUS four-legged pest is the mole. He raises unsightly ridges in lawns and beds, may erect volcano-like mounds at the entrance to his runs, destroys roots while making his runs, and feasts on tulips and other bulbs, although our eastern mole is primarily a meat eater.

Since his main diet consists of subterranean worms, grubs and other animals he is forced to move out if the food supply is destroyed. That seems to be the simplest way of getting rid of him, at least for a while. Lawns grub-proofed against Japanese beetles never are bothered by moles, and garden beds so treated will be equally free. DDT, chlordane, dieldrin, aldrin and arsenate of lead are effective.

Other Repellents

There are many other ways to free the garden of moles, such as trapping, running the car exhaust into the runways or inserting such diversified materials as commercial mole pellets, castor beans, naphthalene flakes, paradichlorobenzene pellets, coffee grounds, rags dipped in household ammonia, a paste of turpentine and salt, lye crystals, a mixture of one teaspoonful Paris green and half a cup of moist salt, poisoned peanuts or wheat, fresh ground pepper, meat scraps or

earthworms rolled in red squill, bisulphide of carbon (fire hazard) and even mouse traps. Mo-Go is the name of a commercial product said to give good results; Mole-Nots is another.

Running water into the tunnels for five minutes or longer has given good results on heavy soil especially if done early in summer to drown the young in the nest. Glass jars four to six inches wide at the mouth and seven or eight inches deep are filled with three inches of water and the inside hollow below the top is greased with fat. Sunk into the runs, level with the floor, they will attract and drown the moles.

Moles are suspicious of any foreign substances and quickly detect any human scent of material handled with bare hands. This accounts in part for the varied results obtained by different gardeners.

You may be able to catch them at work with the greatest activity in early morning and again at 11 a.m. and 3 p.m. or after a heavy rain. Insert the spade deeply six inches behind the moving earth, lift out quickly and put an end to the intruder with a pat from the spade. Work quietly, quickly and cautiously to prevent revealing your presence through soil vibrations or noise. To localize the area tramp down all runs beforehand. This also is necessary to determine active runs for trapping or baiting. Where gaseous liquids or solids are used close off all openings.

Some gardeners have found that pinwheels made for the amusement of youngsters will drive moles away if placed throughout the garden. Evidently the vibration scares them away.

American Museum of Natural History

Common mole in its runway under turf.

How to Foil Rabbits

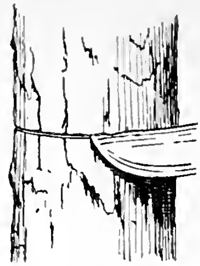
Rabbits are another serious pest in many gardens and the easiest way to foil them is to place a wire fence that need not be more than two feet high around vulnerable areas. There must be no break and the wire must reach a little below the soil surface. Traps are effective if placed in narrow openings in hedges or other tight places frequently used for travel.

There also are many repellents that give variable results. Among those dusted on the plants are dried blood, red pepper, eight parts powdered tobacco with one part powdered alum and a mixture of dusting sulphur and pulverized limestone.

Among the sprays reported effective are two tablespoonfuls aluminum sulphate and one tablespoonful detergent in a gallon of water; three ounces of epsom salt in a gallon of water; one tablespoonful Lysol to a gallon of soapy water and two teaspoonfuls nicotine sulphate also in a gallon of soapy water. Other good repellents are tobacco stems placed among the plants or small bags each with one or two mothballs attached to short sticks and inserted among the plants.

FORCED FRUITING

Girdling or ringing a tree trunk may stimulate it to flower



Ernest G. Christ

Reprinted from *The New York Times,* May 27, 1956

SOME fruit trees and flowering shrubs fail to produce fruit buds and flowers, even after they have reached the age when they should be productive. Shrubs and trees and even varieties of trees differ in the number of years they must grow before they are mature enough to bloom and fruit. Some apples, for example, flower in four to six years, others require eight to ten years.

The reason for any particular plant or variety not flowering within a normal growth span usually is the too vigorous growth of the plant. It is an old, established fact that a plant which is producing an abundance of vegetative growth is less productive than one which is growing moderately. Conversely, a plant that has been weakened from one cause or another often blooms prolifically. A dry summer, for example, is frequently followed by heavy bloom on apple and dogwood trees.

Food In Reserve

One of the explanations for this is that food reserves accumulate in the plant that is growing slowly and more is available for fruit and flower bud formation. Such reserves are depleted in the rapidly growing plant, since they are used up for vegetative growth.

Thus, one of the first matters to be checked if a lilac or dogwood has not bloomed, is the question of fertilizer. If the home owner has been applying fertilizer to the shrub annually or twice annually, that might be the answer, for such feeding stimulates vegetative growth at the expense of flower production. The gardener might try withholding fertilizer for a year or two.

Of course, if a plant is growing in shade, it may not bloom; sunlight is needed to produce carbohydrates. In the fall these carbohydrates are stored in the roots, and it is only when there is a surplus that they are stored in stems, too. This excess in the stems, it is believed, stimulates bud development. Where practical, it would be wise to transplant a bloomless shrub to a sunny spot.

A method of inducing fruit bud formation and blossoming in fruit trees and grapevines is called ringing or girdling. With apple, cherry and olive trees, for example, a thin band of bark is removed from the trunk of the tree. This thin band, cut no wider than ⅛ inch, is removed soon after the blossoming period. This may vary from April through May depending upon the part of the country. *Care must be taken not to remove too wide a band of bark or the tree may be killed.*

To reduce the possibility of infection in the ring a coat of tree paint can be applied. On grapevines a cut is made with a sharp knife once aronnd the main trunk; no bark is removed.

Timing is important for successful results from girdling. Next year's fruit bud formation begins within a month to six weeks after this year's flowering. During this period the wound on the trunk of the tree or vine prevents those foods manufactured by the leaves from

Gottscho-Schleisner

Fruit trees and grapevines can often be induced to flower and fruit by very light girdling, that is, removing a narrow band of bark no wider than 1/8 inch from the trunk.

returning to the roots through the bark tissue. These foods are accumulated in the upper part of the tree above the girdling and are used for fruit and flower bud initiation.

To illustrate the value of this practice one orchard of DELICIOUS apple trees may be cited. The orchard was twelve years old and had produced few blossoms and little fruit. The trunks were girdled and this year this block of trees blossomed heavily and probably will produce its fourth successive apple crop.

That several of the flowering shrubs will respond in similar fashion to girdling has been observed by Raymond P. Korbobo, Specialist in Ornamental Horticulture, Rutgers University. Wistaria, which is often notoriously slow to blossom, and dogwood need only be girdled by drawing a knife around the trunk through the bark. Following such treatment one wistaria flowered for the first time in nineteen years, and a dogwood bloomed after being flowerless for fourteen years.

Luck With Lilacs

Lilacs respond to root pruning which has a similar effect. In one instance a lilac, which had displayed no bloom for forty-seven years, flowered the spring after it had been root pruned.

Occasionally a twig or small branch or a section of a plant blossoms heavily while the rest of the plant is green but has few or no flowers. In many instances this is the result of a wire label girdling the branch and causing it to bloom. Such girdling can eventually kill the branch.

CHINESE GARDEN ART

"The Silent Traveller," recipient of Brooklyn Botanic Garden's 195[illegible] Forsythia Award, reveals the philosophy behind Chinese garden design

Chiang Yee

Drawings by the author

A CHINESE gardener sets out to arrange plants, trees and flowering shrubs in the manner in which they grow in Nature. Planning the garden in a natural way is the keynote of Chinese garden art. To the Chinese the chief purpose of having a garden is to bring Nature within easy reach, to remind man that he is a part of Nature and dwells in its presence. Chinese philosophy advocates that the harmony between man and Nature is nec[essary] for the maintenance of the peace[ful] rhythm of life. In other words, ma[n] cannot live outside Nature. Happines[s] for him lies in the enjoyment of Natur[e] in being close to it. Those who shut them[selves] up within four walls or seldom se[e] Nature are often miserable, and thei[r] brooding may eventually lead to troubl[e].

The first important features in a Chi[nese]

nese garden are a number of naturally-shaped stones or rocks, generally called ornamental rocks. They are placed in the same way as the stone or marble statues of the Western garden. The Chinese esteem these ornamental rocks highly and think them beautiful pieces of sculpture, created by the inspired hand of Nature and chosen by the artistic mind-eye and good taste of man to represent one form or another of Nature in a garden.

However, these rocks are not mere ornaments, for they also provide a natural setting for the plants. The Chinese regard the stones or rocks as the "bones of the earth" or "skeleton of Nature." They prefer those rocks which have been much battered by wind and water and are ruggedly shaped and marked with holes. As flowering shrubs are often found growing near a rock in Nature, so in a Chinese garden these elements are placed together, as if they belonged to each other.

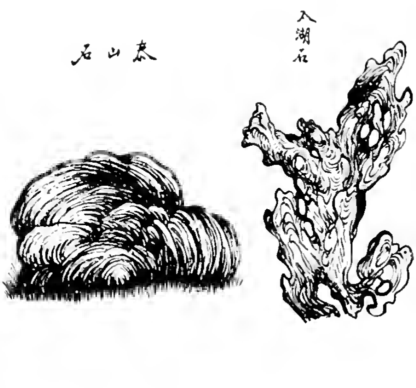
These porous or tunneled rocks, and hollowed and furrowed blocks of stone are not found easily everywhere. They are selected from far and wide within the vast area of China. Choosing these rocks requires good taste, which has to be cultivated by constant observation of the beautiful forms of Nature and the masterpieces of Chinese landscape paintings. The rocks should not suggest artificiality. Thus most of those placed in Chinese gardens have no sharp, straight edges and are not of a plain cube or cone shape. If suitable rocks are unavailable, hillocks of soil or a winding path are substituted.

The second feature of a Chinese garden is its surprises. It is planned so that it will constantly surprise its visitors. Just as when one wanders about the countryside in a mountainous region or along the shore of a river or lake and is constantly amazed and surprised by the beautiful scenery that comes into view, so a Chinese garden is planned so that one cannot see every corner at one look. Thus the distant scene will be purposely hidden by a group of tall trees, a number of rocks, or a small building such as a bower or pavilion, so that the visitor will be able to appreciate and admire what is immediately before his eyes. Then, when he moves to another part of the garden, he will face a different scene.

In a Chinese garden straight lines are avoided if possible. The lines of a building will be purposely broken by a tree or rock placed alongside it, and a short footpath leading to a building and following a stream will be made to wind and twist

Chinese garden design follows principles of Chinese pictorial art in being imaginative, suggestive and natural. Perhaps we can say also that it means to be deceptive. A small garden, if it is well planned and full of surprises, artistically suggested by the ingenious imagination of the designer, can give the impression of being a large garden. Planning a garden in the Chinese manner is great fun!

I believe that from the seventeenth to the early part of the nineteenth century



the Italian and French types of gardens, with their grandeur, magnificent arrangement of trees, lawns, ornaments and pillars, dominated the scene. Their keynote was symmetry and grand scale. However, garden planning in the West began to change in the early nineteenth century, the new style becoming more apparent as the century proceeded. The garden planners now wanted their gardens to appear natural—with everything arranged in accordance with its natural way of growth and surroundings. Thus the keynote in modern garden planning has become asymmetry, for hundreds of years a characteristic of Chinese gardens.

The third feature in Chinese gardens is simplicity. Though this may seem to be opposed to introducing surprises into a garden, actually it is not. In accepting simplicity as one of the principles of garden art, it is understandable why the Chinese did not develop the art of creating lawns for their gardens or make any attempt to work out patterns with flowers, as has been done in the famous floral-clock in the garden of West Princes Street, in Edinburgh, Scotland; it is also obvious why they did not assemble many flowering herbs and trees, as has been done for educational purposes by botanic gardens. The Chinese prefer to enjoy the flowers as they are, neither grouping them artificially nor stressing their color. According to Chinese philosophy, each flower has its own individuality or personality. It is enjoyed for its decorative qualities, naturalness, and symbolic significance. The art of gardening in China is closely linked to Chinese philosophy and literature and, in particular, to Chinese poetry and painting. So the Chinese arrange flowers simply and seldom in masses.

In conclusion I would like to quote the words of the eminent botanist, Ernest Henry Wilson (from *China—Mother of Gardens*, Stratford Company, 1929): "Ornamental gardening has been practiced in China from immemorial time, and the people are endowed with an innate love for flowers and gardens. Floral calendars are kept in every house above the poorest, and volumes of poems have been written in praise of the Moutan Paeony, Camellia, Plum, Chrysanthemum, Lotus-lily, Bamboo, and other plants. . . . The dwelling of the poorest peasant is usually enlivened by an odd plant or two, and the courtyard of the shopkeeper and innkeeper always boasts a few flowers of one sort or another. . . .

"In the middle of the last century many ornamental plants were received from the gardens of Japan, and botanists, assuming that these were the natives of the country, gave the specific name *japonica* to certain of them. Subsequent knowledge has, however, conclusively proved that a number of the so-called Japanese plants are only cultivated forms of plants originally natives of China. Thus has the geographer and botanist unwittingly obscured China's right to be termed the Kingdom of Flowers."

WORTH READING

A SELECTED LIST OF RECENT NONTECHNICAL BOOKS, MAGAZINE ARTICLES AND EXPERIMENT STATION BULLETINS

General—For All Gardeners

ALICE EASTWOOD'S WONDERLAND, by Carol Green Wilson. Published by California Academy of Sciences, San Francisco, 1955. 222 pages. $5.00.

The adventures of a botanist, an ageless woman who lived in a world of discovery forever new.

THE ART OF GROWING MINIATURE TREES, PLANTS AND LANDSCAPES, by Tatsuo Ishimoto. Published by Crown, New York, 1956. 143 pages. $2.95.

A well written and illustrated guide to the popular Japanese art form, bonsai.

DESERTS, by Delia Goetz, illustrated by Louis Darling. Published by William Morrow, New York, 1956. 64 pages. $2.00.

A fascinating little book, profusely illustrated and set in large type.

A FIELD GUIDE TO THE FERNS AND THEIR RELATED FAMILIES, by Boughton Cobb. Published by Houghton-Mifflin, Boston, 1956. 281 pages. $3.75.

This well-illustrated, concisely-written guide, that will slip easily into the pocket, is the latest in the Peterson Field Guide Series.

THE GARDENER'S BUG BOOK, by Cynthia Westcott. Published by The American Garden Guild and Doubleday, Garden City, New York, 1956. 579 pages. $7.50.

A completely rewritten edition of an old standby, this book will, like its forerunner, be an indispensable reference.

HAWKS, by Charles L. Ripper. Published by William Morrow, New York, 1956. 64 pages. $2.00.

Set in large type and superbly illustrated by the author, this slim book about the king of the air will interest all ages.

JAPANESE AND MINIATURE GARDENS, by Leslie Wollard. Published by Dover Publications, New York, 1953. 95 pages. 65¢.

Gardening on a small scale—the making of miniature and Japanese gardens.

LIBERTY HYDE BAILEY, by Philip Dorf. Published by Cornell University Press, Ithaca, New York, 1956. 259 pages. $3.50.

An informal biography of a well-loved American patriarch, a man who, until his recent death at the age of ninety-seven, was a teacher, writer, botanist, horticulturist, plant explorer, poet and philosopher.

MEN AND GARDENS, by Nan Fairbrother. Published by Knopf, New York, 1956. 271 pages. $5.00.

The styles of gardening through the ages and the philosophies and ways of feeling behind them.

NATURE PHOTOGRAPHY GUIDE, by Herbert D. Shumway. Published by Greenberg, New York, 1956. 126 pages. $1.95.

A handbook for photographing the landscape and wildlife with a still or a movie camera.

NATURE'S WONDERS IN FULL COLOR, edited and compiled by Charles L. Sherman. Prepared in cooperation with American Audubon Society. Published by Hanover House, Garden City, New York, 1956. 252 pages. $7.50.

A stimulating nature study lavishly illustrated with over 450 colored plates; includes also an introduction to nature color photography.

PROSPERITY BEYOND TOMORROW, by Samuel H. Ordway, Jr. Published by Ronald Press, New York, 1956. 208 pages. $3.00.

There is a challenge to all Americans in this stimulating projection of our country's future in terms of material and human resources.

THE SPIRIT OF THE WILD, by William J. Long. Published by Doubleday, Garden City, New York, 1956. 256 pages. $4.00.

The author shares his experiences of a lifetime in the wild, imparting to ever wild creature a distinct individuality.

TREASURY OF AMERICAN GARDENS by James M. Fitch and F. F. Rockwell Published by Harper, New York, 1956. 17 pages. $12.50.

America's finest gardens are pictured i color in this handsome book.

WE MADE A GARDEN, by Margery Fish. Published by Transatlantic Arts, Hollywood-by-the-Sea, Florida, 1956. 120 pages $2.75.

Two beginning gardeners make a smal cottage garden in Somerset, England.

THE POPULATION EXPLOSION, b Karl Sax. Headline Series No. 120. Published by Foreign Policy Association, Inc New York. 64 pages. 35¢

A thought-provoking discussion of th problems posed by a population increasin faster than the available food will sup port.

Garden Flowers

ANEMONES FOR MARKET AND GARDEN, by Roy Genders. Published by Faber & Faber, London, 1956. 123 pages. $1.75.

A thorough coverage of the anemone—historical background; culture, both under glass and in the garden; propagation; use in the garden design; and species for the garden.

CHRYSANTHEMUMS FOR EVERYONE, by Fred W. Loads. Published by Dover Publications, New York, 1955. 86 pages. 65¢.

A little British guide to chrysanthemum culture.

DAHLIA GROWING, by T. R. H. Lebar. Published by Dover Publications, New York, 1955. 70 pages. 65¢.

A British handbook on dahlia culture.

GARDEN ROSES, by Stanley B. Whitehead. Published by Dover Publications, New York, 1955. 96 pages. 65¢.

This little guide to rose growing, though written for the English gardener, is of value to all rose enthusiasts.

THE GUIDE TO ROSES, by Bertram Park. Published by Van Nostrand, Princeton, New Jersey, 1956. 288 pages. $5.95.

Though written for the English gardener, this informative guide will prove helpful and worthwhile to rose fanciers of many climes.

LILIES AND THEIR CULTIVATION, b M. E. Leeburn. Published by Dover Publications, New York, 1955. 96 pages. 65¢.

A British guide to growing lilies.

MOUNTAIN FLOWERS, by John Rave and Max Walters. Published by Macmillar New York, 1956. 240 pages. $5.00.

A well illustrated study of the mountai flora of the British Isles, including map showing distribution of various species an a good bibliography.

MUMS FOR FALL PLANTING, by I M. Berninger and G. E. Beck. Universit of Wisconsin (Madison, Wisc.) Extensio Service Circular 532, October, 1956. 7 page

Selecting chrysanthemums for norther climates and establishing, maintaining an increasing a chrysanthemum planting.

ROSES FOR EVERY GARDEN, by R. Allen. Revised edition. Published by M Barrows, New York, 1956. 218 pages. $4.5

An up-to-date edition of a long-popul reference to rose culture.

SNOWDROPS AND SNOWFLAKES, b F. C. Stern. Published by The Royal Horticultural Society, London, 1956. 129 page About $3.00.

An authoritative study of the gener *Galanthus* and *Leucojum*.

Indoor and Greenhouse Gardening

ABC OF ORCHID GROWING, by John V. Watkins. Third edition. Published by Prentice-Hall, Englewood Cliffs, New Jersey, 1956. 190 pages. $3.50.

A basic guide to orchid growing, including specific cultural notes for the most commonly grown genera.

CACTI AND SUCCULENTS, by Lawrence W. Cahill and Peter J. Panting. Published by Dover Publications, New York, 1953. 102 pages. 65¢.

A compact little guide to the culture of cacti and succulents.

CACTUS GUIDE, by Ladislaus Cutak. Published by Van Nostrand, Princeton, New Jersey, 1956. 144 pages. $3.95.

An attractive, concise guide to cactus growing written by the horticulturist in charge of the cactus collection at the Missouri Botanical Garden.

THE COMPLETE BOOK OF GREENHOUSE GARDENING, by Henry T. and Rebecca Northen. Published by Ronald Press, New York, 1956. 353 pages. $6.50.

A good, practical guide to gardening under glass, helpful to the new greenhouse owner as well as the experienced.

AN EASY GUIDE TO AFRICAN-VIOLETS, by William L. Meachem. Published by Hearthside, New York, 1956. 64 pages. $1.95.

A concise and easy-to-follow guide to African-violet culture.

GARDENING IN A SMALL GREENHOUSE, by Mary Noble and J. L. Merkel. Published by Van Nostrand, Princeton, New Jersey, 1956. 236 pages. $4.95.

A good reference for the gardener who has discovered the fascination in growing all kinds of plants under glass.

GREENHOUSE GARDENING AROUND THE YEAR, by Marion Dulles. Published by Macmillan, New York, 1956. 195 pages. $3.75.

Month-by-month in the greenhouse, a chronicle that is readable as well as practical.

THE ILLUSTRATED REFERENCE ON CACTI AND OTHER SUCCULENTS, by Edgar Lamb. Published by Pitman, New York, 1955. 313 pages. $10.00.

An easy-to-use recognition guide to cacti and other succulents.

INDOOR PLANT GROWING, by Stanley B. Whitehead. Published by Dover Publications, New York, 1954. 94 pages. 65¢.

An introduction to indoor gardening.

ORCHID GROWING, by John W. Blowers. Published by Dover Publications, New York, 1955. 94 pages. 65¢.

A little British handbook of orchid culture.

TERRARIUMS, by T. J. Sheehan. Agricultural Extension Service, University of Florida (Gainesville, Fla.). Circular 149, April, 1956. 3 pages.

Selecting plants and making and caring for a small terrarium.

Gardening Techniques, Landscaping

THE COMPLETE BOOK OF GARDENING AND LAWN CARE, by Will Peigelbeck. Published by Random House, New York, 1956. 144 pages. $2.95.

An easy-to-follow guide for the beginning gardener.

FLOWER GROWING IN THE NORTH, by George E. Luxton. Published by University of Minnesota Press, Minneapolis, 1956. 313 pages. $3.95.

A month-by-month guide to gardening in regions where winters are very cold and growing seasons are short.

SOIL STERILIZATION, by W. J. C. Lawrence. Published by Macmillan, New York, 1956. 169 pages. $3.50.

A comprehensive discussion of the sterilization of soil, with techniques for the amateur gardener as well as the commercial greenhouse grower.

A GUIDE TO HOME LANDSCAPING, by Donald J. Bushey. Published by McGraw-Hill, New York, 1956. 295 pages. $4.95.

A concisely written, practical guide to landscaping for the homeowner.

LANDSCAPING FOR WESTERN LIVING (A SUNSET BOOK). Published by Lane, Menlo Park, California, 1956. 192 pages. $2.00.

How to transform the property into a deeply satisfying space for living is the purpose of this book for Westerners.

LAWNS AND LANDSCAPING HANDBOOK, by Thomas H. Everett. Published by Arco, New York, 1956. 144 pages. $2.00.

An introduction to landscaping and lawn building for the new homeowner.

PLANT PROPAGATION AND GARDEN PRACTICE, by R. C. M. Wright. Published by Criterion Books, New York, 1956. 192 pages. $4.50.

This well-illustrated British book is a good guide to all kinds of plant propagation techniques.

ROCK GARDENING, by Roy Genders. Published by Dover Publications, New York, 1955. 114 pages. 65¢.

A guide to rock gardening, originally published in England, where this type of gardening has long been a specialty.

ROYAL HORTICULTURAL SOCIETY DICTIONARY OF GARDENING, edited by Patrick M. Synge. Published by Oxford University Press, New York, 1956. 335 pages. $10.00.

A supplement to the four-volume encyclopedia of horticulture, it includes recommended varieties of flowers, fruits and vegetables and other timely information.

BONSAI, PHOTOS OF NOW FAMOUS MINIATURE TREES edited by Kenji Murata. Published by Kojyu-En Nursery, Tokyo, Japan, 1956. About $2.50.

Famous bonsai specimens pictured and described. The caption text has been translated from the original Japanese.

SUCCESSFUL GARDENING WITHOUT SOIL, by C. E. Ticquet. Published by Chemical Publishing Co., New York, 1956. 176 pages. $2.75.

A good practical guide to growing plants in nutrient solutions.

WHAT'S NEW IN GARDENING, by P. P. Pirone. Published by Hanover House, Garden City, New York, 1956. 254 pages. $3.50.

A fascinating book for all who want to garden in the modern manner. A general survey of all phases of gardening, with a spotlight on the new.

WINDOW BOX GARDENING, by Henry Teuscher. Published by Macmillan, New York, 1956. 180 pages. $3.95.

For the urbanite whose gardening is confined to a window, this book is indispensable; and to the others, it will be an introduction to an imaginative and enjoyable way of gardening.

WHAT TREE SHALL WE PLANT? by Herbert J. Cran, Jr., and Harold O. Perkins. Published as a public service by and obtainable from The Connecticut Light and Power Co., The Connecticut Power Co., The Hartford Electric Light Co., Housatonic Public Service Co., The Southern New England Telephone Co. and The United Illuminating Co. 33 pages.

A well-planned, informative booklet telling how to select the proper tree for the location, be it near a street light or utility wire, in the utility strip edging the street or in the middle of the private lawn.

INSECT AND DISEASE CONTROL ON VEGETABLES, by Donald MacCreary, J. W. Heuberger and R. F. Stevens. University of Delaware Agricultural Extension Service (Newark, Del.). Extension Folder 45.

Notes on the control of various common pests in the vegetable garden.

CONTROL OF FRUIT INSECTS AND DISEASES IN ORCHARDS AND HOME PLANTINGS, by L. H. Stearns, J. W. Heuberger and R. F. Stevens. University of Delaware Agricultural Extension Service (Newark, Del.). Extension Folder 44.

What sprays to use for apples, grapes and peaches and when to apply them.

INSECTS AND OTHER PESTS OF GLADIOLUS AND THEIR CONTROL, by E. G. Kelsheimer. University of Florida Agricultural Experiment Station (Gainesville, Fla.). Circular S-91, January, 1956. 24 pages.

The most important pests of gladiolus—their identification and control. Also a useful table of dilutions for sprays and compatibility chart showing which insecticides can be mixed together, or with fungicides or nutrient solutions.

THRIPS ON PRIVET AND OTHER INSECTS ON ORNAMENTALS, by John C. Schread. Connecticut Agricultural Experiment Station (New Haven, Conn.) Circular 201, August, 1956. 11 pages.

One of an informative series on experimental control of plant pests. In addition to control of thrips on privet this circular discusses control of scale on magnolia and tulip-tree, leafminer and psyllid on boxwood and whitefly on mountain-laurel.

SYSTEMIC INSECTICIDES TO CONTROL MEALYBUG, SCALE, APHIDS AND CYCLAMEN MITE ON ORNAMENTALS, by John C. Shread. Connecticut Agricultural Experiment Station (New Haven, Conn.). Circular 200, July, 1956. 18 pages.

Evaluation of the effectiveness of several systemic insecticides used in experiments—the dosages used and the effects of the chemical on the plant.

MAKING A NEW LAWN, by James Tyson. Michigan State University (East Lansing, Mich.). Cooperative Extension Service Folder F-211, 1956. 6 pages.

Clear, brief instructions for soil preparation, and sowing and maintaining a new lawn.

CARE OF AN ESTABLISHED LAWN, by James Tyson. Michigan State University (East Lansing, Mich.). Cooperative Extension Service Folder F-212, 1956. 8 pages.

Includes liming, feeding, watering, mowing and winter care.

GROWING GOOD VEGETABLE PLANTS, by J. O. Dutt, R. F. Fletcher and R. S. Kirby. Pennsylvania State University (University Park, Penna.). Extension Service Circular 459, 1956. 29 pages.

Complete directions for raising vegetable plants, written for both home and commercial grower. Includes hot-frame construction, soil preparation, sowing seed and caring for seedlings.

HOME PROPAGATING UNITS, by T. J. Sheehan. Agricultural Extension Service, University of Florida (Gainesville, Fla.). Circular 148, April, 1956. 4 pages.

Easy-to-follow directions for building and operating various types of simple propagating units.

FERTILIZERS FOR FRUIT CROPS, by A. L. Kenworthy, R. P. Larsen and H. K. Bell. Michigan State University (East Lansing, Mich.). Cooperative Extension Service Folder F-244, 1956. 16 pages.

Determining fertilizer needs and applying commercial fertilizers and mulches.

LANDSCAPE PLANNING FOR RESIDENTIAL PROPERTIES, by D. Newton Glick, Michigan State University (East Lansing, Mich.). Cooperative Extension Service. Miscellaneous Series Circular E-2. 23 pages.

Clear, concise suggestions for selecting a site, placing buildings and planting the grounds. Also includes notes on taking full advantage of microclimates of the property.

LANDSCAPE PLANNING FOR RURAL HOMES, by Joseph T. Cox. Michigan State University (East Lansing, Mich.). Cooperative Extension Service. Miscellaneous Series Circular E-1. 32 pages.

Step-by-step plans for landscaping the rural home.

Trees, Shrubs, Lawns, Ground Covers

BERRIED TREASURE, by F. Kingdon-Ward. Published by Robert M. McBride, New York, 1956. 192 pages. $4.95.

Berried shrubs that give autumn and winter color to the garden, as described by a noted British botanist and plant explorer.

THE COMPLETE BOOK OF LAWNS, by F. F. Rockwell and Esther C. Grayson. Published by The American Garden Guild and Doubleday, Garden City, New York, 1956. 190 pages. $3.95.

A guide to lawn building and care, including the selection of grasses best adapted to specific climates.

GROUND COVER PLANTS, by Donald Wyman. Published by Macmillan, New York, 1956. 175 pages. $4.75.

This valuable group of plants is treated thoroughly in this little book. Included are descriptions of ground-cover plants and notes on their planting, maintenance, winter protection, hardiness, propagation and pruning.

ILLUSTRATED GUIDE TO TREES AND SHRUBS, by Arthur Harmount Graves. Revised edition. Published by Harper, New York, 1956. 271 pages. $6.00.

The revised edition of this outstanding guide contains an excellent winter key. The key is obtainable separately from the author, Wallingford, Connecticut.

MODERN RHODODENDRONS, by E. H. M. and P. A. Cox. Published by Thomas Nelson, New York, 1956. 193 pages. $5.25.

A British study of the popular rhododendron genus, including cultivation, propagation and descriptions of many species of rhododendrons and azaleas.

OLD SHRUB ROSES, by Graham Stuart Thomas. Published by Branford, Boston, 1956. 224 pages. $6.50.

The development of the rose and old roses now in cultivation are the subjects of this British book.

ORNAMENTAL TREES, AN ILLUSTRATED GUIDE TO THEIR SELECTION AND CARE, by Evelyn Maino and Frances Howard. Published by University of California Press, Berkeley 4, California, 1956. 223 pages. $3.75.

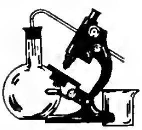
A profusely illustrated, easy-to-read handbook on ornamental trees for the western gardener.

ORNAMENTAL VINES FOR FLORIDA, by R. D. Dickey, Erdman West and Harold Mowry. University of Florida Agricultural Experiment Station (Gainesville, Fla.). Bulletin 571, February, 1956. 72 pages.

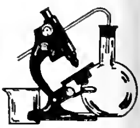
Landscape uses, culture and descriptions of vines suitable for gardens in Florida and similar climates.

LANDSCAPE PLANTS THAT INVITE BIRDS, by G. W. Longenecker. University of Wisconsin (Madison, Wisc.). Extension Service Circular 514, January, 1956. 7 pages.

A listing of these plants with brief descriptions.



Science for Gardeners



CHROMOSOME BOTANY, by C. D. Darlington. Published by George Allen & Unwin, London, 1956. 188 pages. About $3.00.

The breeding of cultivated and ornamental plants is highlighted in this book about chromosomes, the heredity-governing bodies of a living cell.

ELEMENTS OF GENETICS, by Edward C. Colin. Third edition. Published by McGraw-Hill, New York, 1956. 498 pages. $5.75.

A clear, easily understood introduction to genetics, the science of heredity.

GENERAL BIOLOGY, by Willis H. Johnson, Richard A. Laubengayer and Louis E. De Lanney. Published by Henry Holt, New York, 1956. 618 pages. $6.95.

This college text surveys the field of biology, and includes structure, functions and classes of plants, and notes on heredity, evolution and ecology. Laboratory manual ($2.75), written by same authors, accompanies text.

THE WORLD OF PLANT LIFE, by Clarence J. Hylander. Second edition. Published by Macmillan, New York, 1956. 653 pages. $8.95.

A survey of the plant world, from the most primitive algae to the highly complex plants such as orchids and roses.

Flower Arrangement

CHINESE FLOWER ARRANGEMENT, by H. L. Li. Published by Hedera House, Philadelphia, 1956. 122 pages. $4.00.

This interesting book will give the flower arranger new insight into the Oriental way of appreciating and enjoying the beauty of flowers.

HOW TO MAKE CUT FLOWERS LAST, by Victoria R. Kasperski. Published by M. Barrows, New York, 1956. 191 pages. $2.95.

The techniques for making flowers and foliages last after they are cut.

THE MAGIC WORLD OF FLOWER ARRANGING, by Myra J. Brooks with Mary Alice and John P. Roche. Published by M. Barrows, New York, 1956. 192 pages. $10.00.

A handsome, beautifully illustrated book that will spark the imagination of the flower arranger.

STUDIO BOOK OF FLOWERS AND FLOWER ARRANGEMENTS. Published by Crowell, New York, 1956. 224 pages. $10.00.

An attractive book that will be a source of inspiration and guidance to all flower arrangers.

FOLIAGE ARRANGEMENTS, by Emma Cyphers. Published by Hearthside, New York, 1956. 128 pages. $3.50.

Selecting, cutting and conditioning leaves from trees, shrubs and house plants for long-lasting, inexpensive arrangements.

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Articles by Title

Subject Index

Bold face *page numbers indicate illustrations.*

CORRECTION

Perny holly, listed as a smooth-leaved holly on page 243, is a spiny-leaved species.